

PHILOSOPHICAL  
TRANSACTIONS.

Giving Some

ACCOUNT

OF THE

*Present Undertakings, Studies, and Labours*

OF THE

INGENIOUS,

In Many

Considerable Parts of the WORLD.

---

V O L. XXIX. For the Years 1714, 1715, 1716.

---

L O N D O N:

Printed for W. INNYſ, at the *Princes-Arms* in St. Paul's  
Church-Yard. MDCCXVII.

*Bibliotheca Upsal.*

T O  
*Sir Isaac Newton, Kt.*  
P. R E S I D E N T,

And to the  
Council and Fellows  
O F T H E  
Royal Society  
O F  
L O N D O N

Instituted for the  
Advancement of *Natural Knowledge*;  
T H I S

Twenty Ninth V O L U M E  
O F  
Philosophical Transactions  
I S  
HUMBLY DEDICATED,  
B Y

*Edmond Halley, R. S. Secr.*

THE COMPANION  
OF THE ARTS AND MANNERS

Numb. 338. Beginning  
the 29th Volume.

# PHILOSOPHICAL TRANSACTIONS.

---

For the Months of January, February and March, 1714.

---

## The CONTENTS.

I. **T**HE Preface to the Reader, giving an Account of the Publisher's Design and Method, and inviting the curious Observers of the Phænomena, the diligent Inquirers into the Powers and Operations of Natural Agents, and the happy Inventors of new Discoveries, to contribute towards the carrying on these Publications with Success, by generously communicating their Observations, Discoveries and Inventions to the Publisher.

II. Logometria: Auctore Rogero Cotes, Trin. Coll.  
Cantab. Socio. Astronomiæ & Philosophiæ  
A . . . . . Experi.

## The CONTENTS.

Experimentalis Professore PLUMIANO, &  
R. S. S.

- III. *An Extract from the Acta Eruditorum, for the Month of March, 1713. p. 111. Being a Dissertation concerning the dreadful contagious Distemper, seizing the Black Cattle in the Venetian Territories, and more especially about Padua.*
- IV. *A Recipe: Or the Ingredients of a Medicine for the late spreading Distemper amongst Cows. Sent lately from Holland, where it was made use of with Success.*
- 

THE



---



---

# THE PREFACE.

**T**HE Philosophical Transactions, (begun to be Published by that indefatigably diligent Promoter of Learned Correspondence, Mr. Oldenburgh, the first who attempted any thing of this Nature) having been sufficiently known to the Curious, and always acceptable to the Learned, when due care has been taken in the choice of the Collections so recommended to the inquisitive and intelligent Reader; a long Preface must appear wholly unnecessary.

However, it may not be amiss to inform the Learned and Ingenious, of some Particulars of the present Publisher's Design: Which is;

First, To present the Publick with such short Tracts, as might otherwise be lost to Posterity, if printed in single Sheets or Pamphlets.

Secondly, To give the Extracts, for the most part, of the Material, omitting the Preambles and Conclusions, and the useless parts of such Letters as Correspondents shall please to honour him with, relating to the Improvement of Natural Philosophy, Mathematicks, or Mechanicks.

Thirdly, To give an exact account of such Experiments, as having been made before the Illustrious ROYAL SOCIETY, they shall please to order or permit the Publication of.

Fourthly,

Fourthly, *To give, as Opportunity offers, the Abstracts or Accounts of such Books, relating to the Ends of the Royal Society's Institution, as the Authors shall please to communicate themselves; which shall be distinguished from others: or of such as are with difficulty to be procured in England, or extraordinary in their kind; upon which there shall sometimes be added some Remarks.*

*To this Undertaking the Publisher invites and desires all real Lovers of Knowledge to contribute their Assistance, by communicating their Observations, Discoveries, or Inventions; which shall not only be faithfully and duly Published, with due Acknowledgment; but some Returns made them, by Informations of what shall be thought acceptable to the Gentlemen, who shall think fit to entertain a Philosophical Correspondence: Who are desired, in any Treatise or Discourse they shall so communicate, to omit all Personal Reflections; for if such should happen to be inserted, the Publisher shall take the liberty of leaving them out; it being his Opinion, that Disputes on Philosophical Subjects, may be managed with the utmost Candor, Respect and Friendship by the Disputants, whose only Aim ought to be the Search of Truth.*

*The Gentlemen willing to encourage this Undertaking, are desired to direct their Letters, To be left at the Royal Society's House, in Crane-Court, in Fleetstreet, London, for the Secretary of the ROYAL SOCIETY.*

L O G O-

# LOGOMETRIA

Auctore

ROGERO COTES,

Trin. Coll. Cantab. Soc.

Astr. & Ph. Exp. Professore PLUMIANO, & R. S. S.

---

Eruditissimo Viro

EDMUNDO HALLEIO,

Societatis Regalis Secretario S. P.

**M**itto tibi, hortatu Illustrissimi Præsidis NEWTONI,  
*quæ aliquot abhinc annis conscripseram de Rationi-  
bus dimetiendis. Tu vero, quum & Ipse dudum in eodem  
Argumento præclare versatus fueris, pro solito tuo candore,  
tentamen hoc qualecunque benigne accipies. Vale.*

**A**

GITUR in hoc Tractatu de *Mensuris Rationum*. Hæ  
Mensuræ sunt quantitates cujuscunque generis, quarum  
magnitudines magnitudinibus rationum sunt analogæ. In  
dato itaque Systemate, rationis ejusdem eadem est men-  
sura, duplicatæ dupla, triplicatæ tripla, subduplicatæ sub-  
dupla, fesquiplicatæ fesquialtera: denique quocunque modo per com-  
positionem vel resolutionem auctæ vel diminutæ rationis, similiter

B

aucta

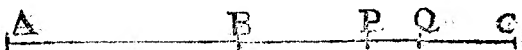
aucta est vel diminuta mensura. Æqualitatis ratio nullam habet magnitudinem, quia nullam addita vel detracta mutationem inducit; rationes quæ dicuntur majoris & minoris inæqualitatis contrarias habent magnitudinum suarum affectiones, quoniam in compositione & resolutione contraria semper efficiunt: itaque si mensura rationis quam habet terminus major ad minorem positiva censeatur, mensura rationis quam habet terminus minor ad majorem erit negativa, mensura vero rationis inter æquales terminos nullius erit magnitudinis. Porro diversa mensurarum oriuntur *Systemata*, prout modis diversis exponitur analogia illa determinata & immutabilis quæ est inter magnitudines rationum. Inde vero patet, exhiberi posse numero infinita *Systemata*, minuendo vel augendo *Systematis* cujusvis dati mensuras omnes in eadem data quacunque proportionem, aut etiam pro mensuris adhibendo quantitates diversi generis. In tanta autem varietate confusionem aliquam oboriri necesse est, ni probe constiterit ad quodnam *Systema* referendæ sint mensuræ singulæ de quibus contingat sermonem institui. Huic malo remedium optime parari potest si mensura datæ alicujus rationis, quæ commodissima videbitur, pro *Modulo* habeatur ad quem constanter in omni *Systemate* mensuræ reliquarum rationum exigantur. Id enim si fiat, statim ex dato illo *Modulo* determinabitur *Systema* totum: nam ex mensuris constabit quæ *Modulo* erunt homogeneæ, quæque eo majores habebunt magnitudines vel minores quo major ille fuerit vel minor, ut ita mensurandarum rationum invariata magnitudinum fervetur analogia inter ipsas mensuras. Patebit igitur in sequentibus rationem quandam dari, dupli inter & tripli rationes intermediam, ad rationem vero tripli aliquanto propius accedentem, quæ proposito nostro non immerito aptissima judicetur, siquidem ipsa rei natura hujus usum suadere ac non incertis indiciiis efflagitare quodammodo videatur. Hanc ego, ex officio ejus desumpto nomine, *Modularem Rationem* appellabo; quo autem pacto ipsa sit accuratius definienda, ostendetur inferius, nunc enim de *Logarithmis* pauca sunt addenda.

*Logarithmi* sunt rationum mensuræ Numerales: solent autem in Canone sic disponi, ut singulis numeris naturali ordine crescentibus, & in serie continua positis adscribatur *Logarithmus*, non quidem ipsius numeri uti vulgo dicitur, sed rationis quam habet numerus ad Unitatem. Exinde vero rationis per quoscunque terminos designatæ facilis est inventio *Logarithmi*. Nam cum ratio antecedentis ad consequentem sit excessus rationis antecedentis ad Unitatem  
supra

supra rationem consequentis ad Unitatem: Logarithmus ejus similiter erit excessus Logarithmi rationis quam habet antecedens ad Unitatem supra Logarithmum rationis quam consequens habet ad Unitatem; hoc est, ut vulgari sermone utamur, excessus Logarithmi antecedentis supra Logarithmum consequentis; neutiquam enim displicet loquendi modus jam à multis annis receptus, si recte intelligatur. Exinde porro peregregium enascitur compendium ad operationes Arithmeticas. Datis enim duobus quibuscunque numeris in se multiplicandis, si quærat<sup>ur</sup> numerus ex multiplicatione productus; quoniam rationes numerorum datorum ad Unitatem, conficiunt simul additæ rationem producti ad Unitatem, & rationum componendarum mensuræ simul additæ conficiunt rationis compositæ mensuram: Logarithmus producti æquabitur Logarithmis numerorum datorum simul sumptis. Ad eundem modum si quærat<sup>ur</sup> numerus ex divisione ortus; quoniam ratio divisoris ad Unitatem è ratione dividendi ad Unitatem detracta relinquit rationem quoti ad Unitatem: habebitur quoti Logarithmus subducendo Logarithmum divisoris è Logarithmo dividendi. Et eodem argumento, si quærat<sup>ur</sup> dati cujusvis numeri quælibet potestas; quoniam ratio dati numeri ad Unitatem per Indicem potestatis multiplicata rationem efficit quam habet numeri potestas ad Unitatem, & mensura prioris rationis multiplicata per eundem Indicem efficit pariter mensuram rationis posterioris: Logarithmus potestatis æquabitur Logarithmo numeri dati per Indicem potestatis multiplicato. Et similiter Logarithmus cujuslibet radices numeri dati æquabitur Logarithmo numeri dati per Indicem radices diviso. Igitur ope Canonis peragetur inventio potestatum & radicum per multiplicationem & divisionem, multiplicatio autem & divisio per additionem & subtractionem. Ceterum de hisce vulgo notis Logarithmorum usibus non est mei instituti fufius differere: missis ergo ambagibus, ad alia nunc me conféro & rem ipsam protinus aggredior.

## PROPOSITIO I.

*Invenire Mensuram Rationis cujuscunque propositæ.*

**P**ROponatur Ratio inter  $AC$  &  $AB$ , cujus Mensuram oportet invenire. Terminorum differentia  $BC$  divisa concipiatur in particulas innumeras quam minimas  $PQ$ , atque ratio inter  $AC$  &  $AB$  in totidem rationes quam minimas inter  $AQ$  &  $AP$ : & si detur magnitudo rationis inter  $AQ$  &  $AP$ , dividendo dabitur ratio quam habet  $PQ$  ad  $AP$ ; atque adeo data illa magnitudo rationis inter  $AQ$  &  $AP$ , per datam quantitatem  $\frac{PQ}{AP}$  exponi potest. Manente  $AP$ , augeri vel minui intelligatur particula  $PQ$  in proportionem quavis; & in eadem proportionem augebitur vel minuetur magnitudo rationis inter  $AQ$  &  $AP$ : capiat-  

tur particula dupla vel tripla, subdupla vel subtripla, & evadet ratio duplicata vel triplicata, subduplicata vel subtriplicata; etiamnum igitur exponetur per quantitatem  $\frac{PQ}{AP}$ . Sed &, assumpta determinata quavis quantitate  $M$ , exponi potest per  $M \times \frac{PQ}{AP}$ : erit ergo quantitas  $M \times \frac{PQ}{AP}$  mensura rationis inter  $AQ$  &  $AP$ . Hæc vero mensura diversam habebit magnitudinem, & ad Systema diversum accommodabitur, pro diversa magnitudine quantitatis assumptæ  $M$ , quæ adeo vocetur Systematis *Modulus*. Jam quemadmodum summa rationum omnium inter  $AQ$  &  $AP$  æqualis est propositæ rationi, quam utique habet  $AC$  ad  $AB$ : ita summa mensurarum omnium  $M \times \frac{PQ}{AP}$  (per Methodos satis notas inveniendi) æqualis erit ejusdem propositæ rationis mensuræ quæsitæ. *Q. E. I.*

*Corol. I.* Terminis  $AP$ ,  $AQ$  ita ad æqualitatem accedentibus, ut quam minima sit eorundem differentia  $PQ$ : crit  $M \times \frac{PQ}{AP}$  vel  $M \times \frac{PQ}{AQ}$  æqualis mensuræ rationis inter  $AQ$  &  $AP$  ad Modulum  $M$ .

*Corol.*

*Corol. 2.* Unde Modulus ille  $M$  est ad mensuram rationis inter terminos  $AQ$  &  $AP$ , ut terminorum alteruter  $AP$  vel  $AQ$  ad terminorum differentiam  $PQ$ .

*Corol. 3.* Data ratione inter  $AC$  &  $AB$ , datur summa omnium  $\frac{PQ}{AP}$ , & summa omnium  $M \times \frac{PQ}{AP}$  est ut  $M$ . Itaque mensura datæ cujuscunque rationis est ut Modulus Systematis ex quo desumitur.

*Corol. 4.* Modulus ergo, in omni mensurarum Systemate, semper æqualis fit mensuræ rationis cujusdam determinatæ atque immutabilis: Quam proinde *Rationem Modularem* vocabo.

### Scholium 1.

Problematis solutio per Exemplum illustrabitur. Sit  $z$  quantitas determinata quævis & permanens, sit vero  $x$  quantitas indeterminata fluxuque perpetuo variabilis, ejusque fluxio sit  $\dot{x}$ ; & quærat mensura rationis inter  $z - x$  &  $z - x$ . Statuatur hæc ratio æqualis rationi inter  $y$  &  $1$ , exponatur autem numerus  $y$  per  $AP$ , fluxio ejus  $\dot{y}$  per  $PQ$ ,  $1$  per  $AB$ : & ex Corollario primo colligetur fluxionem quæsitæ mensuræ rationis inter  $y$  &  $1$  esse  $M \times \frac{\dot{y}}{y}$ . Reponatur jam pro  $y$  valor ejus  $\frac{z+x}{z-x}$ , itemque pro  $\dot{y}$  valoris fluxio

$$\frac{2z\dot{x}}{z-x)^2} : \text{ \& fluxio mensuræ evadet } 2M \times \frac{z\dot{x}}{zz-xx} \text{ vel } 2M \times \frac{\dot{x}}{z-\frac{xx}{z}}$$

sive  $2M \ln \frac{z}{z} + \frac{\dot{x}x^2}{z^3} + \frac{\dot{x}x^4}{z^5} + \&c.$  Atque adeo mensura illa fiet

$$2M \ln \frac{z}{z} + \frac{x^3}{3z^3} + \frac{x^5}{5z^5} + \&c. \text{ Unde patet Corollarium sequens.}$$

*Corol. 5.* Si duarum quantitatum summa sit  $z$  & differentia sit  $x$ ; & sumatur  $2M \frac{x}{z} = A$ ,  $A \frac{xx}{zz} = B$ ,  $B \frac{xx}{zz} = C$ ,  $C \frac{xx}{zz} = D$ , &c: Mensura rationis quam habet quantitas major ad quantitatem minorem, erit  $A + \frac{1}{3}B + \frac{1}{5}C + \frac{1}{7}D + \&c.$

### Scholium 2.

Non absimili computo mensura rationis inter  $1+v$  &  $1$  erit  $M \ln v - \frac{1}{2}v^2 + \frac{1}{3}v^3 - \frac{1}{4}v^4 + \frac{1}{5}v^5 - \&c.$  Unde si mensura illa vocetur  $m$ , erit  $\frac{m}{M} = v - \frac{1}{2}vv + \frac{1}{3}v^3 - \frac{1}{4}v^4 + \frac{1}{5}v^5$ , &c: ac proinde

unde  $\frac{mm}{MM} = vv - v^3 + \frac{1}{12}v^4 - \frac{1}{6}v^5$ , &c; similiterque  $\frac{m^3}{M^3} = v^3 - \frac{1}{2}v^4 + \frac{3}{4}v^5$ , &c; quinetiam  $\frac{m^4}{M^4} = v^4 - 2v^5$ , &c; ac denique  $\frac{m^5}{M^5} = v^5$ , &c.

Ut igitur vicissim, ex data mensura  $m$ , inveniatur ratio quam metitur; addendo æqualia æqualibus habebitur  $\frac{m}{M} + \frac{mm}{2MM} = v$

\*  $-\frac{1}{6}v^3 + \frac{1}{24}v^4 - \frac{1}{60}v^5$ , &c; atque iterum  $\frac{m}{M} + \frac{mm}{2MM} + \frac{m^3}{6M^3}$

$= v * * - \frac{1}{24}v^4 + \frac{1}{40}v^5$ , &c; rursumque  $\frac{m}{M} + \frac{mm}{2MM} + \frac{m^3}{6M^3}$

$+ \frac{m^4}{24M^4} = v * * * - \frac{1}{120}v^5$ , &c; atque tandem  $\frac{m}{M} + \frac{mm}{2MM}$

$+ \frac{m^3}{6M^3} + \frac{m^4}{24M^4} + \frac{m^5}{120M^5} = v * * * *$ , &c; id est,  $\frac{m}{M} + \frac{mm}{2MM}$

$+ \frac{m^3}{6M^3} + \frac{m^4}{24M^4} + \frac{m^5}{120M^5} + \&c. = v$ . Itaque ratio quæ sita inter

$v$  &  $1$ , est ea quam habet  $1 + \frac{m}{M} + \frac{mm}{2MM} + \frac{m^3}{6M^3} + \frac{m^4}{24M^4} + \frac{m^5}{120M^5}$

$+ \&c.$  ad  $1$ . Ponatur  $m = M$ , five  $\frac{m}{M} = 1$ ; & exinde Ratio Modularis erit ea quam habet  $1 + \frac{1}{2} + \frac{1}{6} + \frac{1}{24} + \frac{1}{120} + \&c.$  ad  $1$ .

Eodem modo, si detur ratio inter  $1$  &  $1 - v$ , mensura hujus rationis erit  $M$  in  $v + \frac{1}{2}v^2 + \frac{1}{3}v^3 + \frac{1}{4}v^4 + \frac{1}{5}v^5$ , &c. Et vicissim si detur rationis mensura  $m$ , ratio erit ea quam habet  $1$  ad

$1 - \frac{m}{M} + \frac{mm}{2MM} - \frac{m^3}{6M^3} + \frac{m^4}{24M^4} - \frac{m^5}{120M^5} + \&c.$  Ponatur  $m = M$ ,

five  $\frac{m}{M} = 1$ ; & exinde Ratio Modularis erit ea quam habet  $1$  ad

$1 - \frac{1}{2} + \frac{1}{6} - \frac{1}{24} + \frac{1}{120} + \&c.$  Ex hisce vero patet Corollarium sequens.

*Corol. 6.* Exposito termino  $R$ , si sumatur  $\frac{1}{2}R = A$ ,  $\frac{1}{2}A = B$ ,  $\frac{1}{2}B = C$ ,  $\frac{1}{2}C = D$ ,  $\frac{1}{2}D = E$ , &c. in infinitum; & capiatur  $S = R + A + B + C + D + E + \&c$ : Ratio Modularis erit ea quæ est inter terminum minorem expositum  $R$  & majorem inventum  $S$ . Vel exposito termino  $S$ , si sumatur  $\frac{1}{2}S = A$ ,  $\frac{1}{2}A = B$ ,  $\frac{1}{2}B = C$ ,  $\frac{1}{2}C = D$ ,  $\frac{1}{2}D = E$ , &c. in infinitum; & capiatur  $R = S - A + B - C + D - E + \&c$ : Ratio Modularis erit ea quæ est inter terminum majorem expositum  $S$  & minorem inventum  $R$ . Porro eadem ratio est inter  $2,718281828459$  &c. et  $1$ , vel inter  $1$  &  $0,367879441171$  &c.

Scho-



*Scholium 3.*

Si forte termini minores desiderentur, qui eandem proxime Rationem Modularem ita exhibeant, ut nulli ipsis non majores propius: instituenda erit operatio ad modum sequentem. Dividatur terminus major 2,71828 &c. per minorem 1, vel etiam major 1 per minorem 0,367879 &c. & rursus minor per numerum qui reliquus est, & hic rursus per ultimum residuum, atque ita porro pergatur: &

*Rationes Vera Majores.*

1	0 X 2
2	1
<hr/>	
3	1 X 2
8	3
<hr/>	
11	4 X 1
76	28
<hr/>	
87	32 X 1
106	39
<hr/>	
193	71 X 6
1264	465
<hr/>	
1457	536 X 1
21768	8008
<hr/>	
23225	8544 X 1
25946	9545
<hr/>	
49171	18089 X 10
&c.	&c.

*Rationes Vera Minores.*

0	1
2	0
<hr/>	
2	1 X 1
6	2
<hr/>	
8	3 X 1
11	4
<hr/>	
19	7 X 4
87	32
<hr/>	
106	39 X 1
1158	426
<hr/>	
1264	465 X 1
1457	536
<hr/>	
2721	1001 X 8
23225	8544
<hr/>	
25946	9545 X 1
&c.	&c.

prodibunt quotientes 2, 1, 2, 1, 1, 4, 1, 1, 6, 1, 1, 8, 1, 1, 10, 1, 1, 12, 1, 1, 14, 1, 1, 16, 1, 1, &c. His inventis, perficiendæ sunt binæ rationum columnæ, quarum altera terminos continet rationem habentes vera majorem, altera terminos quorum ratio est vera minor; in-  
eundo computationem à rationibus 1 ad 0, 0 ad 1, quæ remotissimæ sunt à vera; inde autem exorsam deducendo ad rationes reliquas,  
quæ

quæ continue ad veram propius accedunt. Multiplicentur itaque termini 1 & 0 per quotientem primum 2, & scribantur facti 2 & 0 infra terminos 0 & 1; & addendo prodibit ratio  $2 \div 0$  ad  $0 \div 1$ , sive 2 ad 1. Hujus termini multiplicentur per quotientem secundum 1, factique 2 & 1 addantur terminis 1 & 0; & habebitur ratio  $2 - 1$  ad  $1 + 0$ , sive 3 ad 1. Hujus termini multiplicentur per quotientem tertium 2, factique 6 & 2 addantur terminis præcedentibus 2 & 1; & habebitur ratio 8 ad 3. Hujus termini multiplicentur per quotientem quartum 1, factique 8 & 3 addantur terminis præcedentibus 3 & 1; & habebitur ratio 11 ad 4. Hujus termini multiplicentur per quotientem quintum 1, factique 11 & 4 addantur præcedentibus 8 & 3; & habebitur ratio 19 ad 7. Hujus termini rursus multiplicentur per quotientem sextum 4, factique 76 & 28 addantur præcedentibus 11 & 4, ad inveniendam rationem 87 ad 32; & sic porro pergendum quousque libuerit, transitu alternis facto in alteram columnam. Hisce peractis, habebuntur rationes vera majores 3 ad 1, 11 ad 4, 87 ad 32, 193 ad 71, 1457 ad 536, 23225 ad 8544, 49171 ad 18089, &c. Vera autem minores erunt 2 ad 1, 8 ad 3, 19 ad 7, 106 ad 39, 1264 ad 465, 2721 ad 1001, 25946 ad 9545, &c. Atque hæ quidem sunt præcipuæ & primariæ rationes, quibus ad rationem propositam continue appropinquatur.

Quod si exquiratur integra series rationum omnium vera majorum quæ ita dari possint, ut nulla minoribus terminis designata ratio vera major ad veram propius accedat; & similiter series integra rationum omnium vera minorum quæ ita dari possint, ut nulla minoribus terminis designata ratio vera minor ad veram propius accedat: inter primarias illas modo inventas inferendæ sunt aliæ secundariæ rationes. Hæ vero locum habent ubi quotiens unitatem superat. Inveniuntur autem mutata multiplicatione, quæ supra per quotientem facta est, in continuam additionem terminorum tot vicibus quot sunt unitates in quotiente. Sic quia quotiens primus erat 2, termini 1 & 0 bis addendi sunt terminis 0 & 1; & summæ dabunt rationes 1 ad 1, 2 ad 1. Hi ultimi termini 2 & 1, quia quotiens secundus erat 1, semel addendi sunt terminis 1 & 0; & summæ dabunt rationem 3 ad 1. Hi termini 3 & 1, quia quotiens tertius erat 2, bis addendi sunt terminis 2 & 1; & summæ dabunt rationes 5 ad 2, 8 ad 3. Hi ultimi termini 8 & 3, quia quotiens quartus erat 1, semel addendi sunt terminis 3 & 1; & summæ dabunt rationem 11 ad 4. Hi termini 11 & 4, quia quo-

tiens

tiens quintus erat 1, semel addendi sunt terminis 8 & 3; & summæ dabunt rationem 19 ad 7. Hi denique termini 19 & 7, quia quo-

*Rationes Vera Majores.*

1	0 × 2
2	1
<hr/>	
3	1 × 2
8	3
<hr/>	
11	4 × 1
19	7
<hr/>	
30	11
49	7
<hr/>	
68	18
87	7
<hr/>	
106	25
125	7
<hr/>	
144	32 × 1
163	32
<hr/>	
182	39 × 1
201	39
<hr/>	
220	46 × 1
239	46
<hr/>	
258	53 × 1
277	53
<hr/>	
296	60 × 1
315	60
<hr/>	
334	67 × 1
353	67
<hr/>	
372	74 × 1
391	74
<hr/>	
410	81 × 1
429	81
<hr/>	
448	88 × 1
467	88
<hr/>	
486	95 × 1
505	95
<hr/>	
524	102 × 1
543	102
<hr/>	
562	109 × 1
581	109
<hr/>	
600	116 × 1
619	116
<hr/>	
638	123 × 1
657	123
<hr/>	
676	130 × 1
695	130
<hr/>	
714	137 × 1
733	137
<hr/>	
752	144 × 1
771	144
<hr/>	
790	151 × 1
809	151
<hr/>	
828	158 × 1
847	158
<hr/>	
866	165 × 1
885	165
<hr/>	
904	172 × 1
923	172
<hr/>	
942	179 × 1
961	179
<hr/>	
980	186 × 1
1000	186
<hr/>	
1019	193 × 1
1038	193
<hr/>	
1057	200 × 1
1076	200
<hr/>	
1095	207 × 1
1114	207
<hr/>	
1133	214 × 1
1152	214
<hr/>	
1171	221 × 1
1190	221
<hr/>	
1209	228 × 1
1228	228
<hr/>	
1247	235 × 1
1266	235
<hr/>	
1285	242 × 1
1304	242
<hr/>	
1323	249 × 1
1342	249
<hr/>	
1361	256 × 1
1380	256
<hr/>	
1399	263 × 1
1418	263
<hr/>	
1437	270 × 1
1456	270
<hr/>	
1475	277 × 1
1494	277
<hr/>	
1513	284 × 1
1532	284
<hr/>	
1551	291 × 1
1570	291
<hr/>	
1589	298 × 1
1608	298
<hr/>	
1627	305 × 1
1646	305
<hr/>	
1665	312 × 1
1684	312
<hr/>	
1703	319 × 1
1722	319
<hr/>	
1741	326 × 1
1760	326
<hr/>	
1779	333 × 1
1798	333
<hr/>	
1817	340 × 1
1836	340
<hr/>	
1855	347 × 1
1874	347
<hr/>	
1893	354 × 1
1912	354
<hr/>	
1931	361 × 1
1950	361
<hr/>	
1969	368 × 1
1988	368
<hr/>	
2007	375 × 1
2026	375
<hr/>	
2045	382 × 1
2064	382
<hr/>	
2083	389 × 1
2102	389
<hr/>	
2121	396 × 1
2140	396
<hr/>	
2159	403 × 1
2178	403
<hr/>	
2197	410 × 1
2216	410
<hr/>	
2235	417 × 1
2254	417
<hr/>	
2273	424 × 1
2292	424
<hr/>	
2311	431 × 1
2330	431
<hr/>	
2349	438 × 1
2368	438
<hr/>	
2387	445 × 1
2406	445
<hr/>	
2425	452 × 1
2444	452
<hr/>	
2463	459 × 1
2482	459
<hr/>	
2501	466 × 1
2520	466
<hr/>	
2539	473 × 1
2558	473
<hr/>	
2577	480 × 1
2596	480
<hr/>	
2615	487 × 1
2634	487
<hr/>	
2653	494 × 1
2672	494
<hr/>	
2691	501 × 1
2710	501
<hr/>	
2729	508 × 1
2748	508
<hr/>	
2767	515 × 1
2786	515
<hr/>	
2805	522 × 1
2824	522
<hr/>	
2843	529 × 1
2862	529
<hr/>	
2881	536 × 1
2900	536
<hr/>	
2919	543 × 1
2938	543
<hr/>	
2957	550 × 1
2976	550
<hr/>	
2995	557 × 1
3014	557
<hr/>	
3033	564 × 1
3052	564
<hr/>	
3071	571 × 1
3090	571
<hr/>	
3109	578 × 1
3128	578
<hr/>	
3147	585 × 1
3166	585
<hr/>	
3185	592 × 1
3204	592
<hr/>	
3223	599 × 1
3242	599
<hr/>	
3261	606 × 1
3280	606
<hr/>	
3299	613 × 1
3318	613
<hr/>	
3337	620 × 1
3356	620
<hr/>	
3375	627 × 1
3394	627
<hr/>	
3413	634 × 1
3432	634
<hr/>	
3451	641 × 1
3470	641
<hr/>	
3489	648 × 1
3508	648
<hr/>	
3527	655 × 1
3546	655
<hr/>	
3565	662 × 1
3584	662
<hr/>	
3603	669 × 1
3622	669
<hr/>	
3641	676 × 1
3660	676
<hr/>	
3679	683 × 1
3698	683
<hr/>	
3717	690 × 1
3736	690
<hr/>	
3755	697 × 1
3774	697
<hr/>	
3793	704 × 1
3812	704
<hr/>	
3831	711 × 1
3850	711
<hr/>	
3869	718 × 1
3888	718
<hr/>	
3907	725 × 1
3926	725
<hr/>	
3945	732 × 1
3964	732
<hr/>	
3983	739 × 1
4002	739
<hr/>	
4021	746 × 1
4040	746
<hr/>	
4059	753 × 1
4078	753
<hr/>	
4097	760 × 1
4116	760
<hr/>	
4135	767 × 1
4154	767
<hr/>	
4173	774 × 1
4192	774
<hr/>	
4211	781 × 1
4230	781
<hr/>	
4249	788 × 1
4268	788
<hr/>	
4287	795 × 1
4306	795
<hr/>	
4325	802 × 1
4344	802
<hr/>	
4363	809 × 1
4382	809
<hr/>	
4401	816 × 1
4420	816
<hr/>	
4439	823 × 1
4458	823
<hr/>	
4477	830 × 1
4496	830
<hr/>	
4515	837 × 1
4534	837
<hr/>	
4553	844 × 1
4572	844
<hr/>	
4591	851 × 1
4610	851
<hr/>	
4629	858 × 1
4648	858
<hr/>	
4667	865 × 1
4686	865
<hr/>	
4705	872 × 1
4724	872
<hr/>	
4743	879 × 1
4762	879
<hr/>	
4781	886 × 1
4800	886
<hr/>	
4819	893 × 1
4838	893
<hr/>	
4857	900 × 1
4876	900
<hr/>	
4895	907 × 1
4914	907
<hr/>	
4933	914 × 1
4952	914
<hr/>	
4971	921 × 1
4990	921
<hr/>	
5009	928 × 1
5028	928
<hr/>	
5047	935 × 1
5066	935
<hr/>	
5085	942 × 1
5104	942
<hr/>	
5123	949 × 1
5142	949
<hr/>	
5161	956 × 1
5180	956
<hr/>	
5199	963 × 1
5218	963
<hr/>	
5237	970 × 1
5256	970
<hr/>	
5275	977 × 1
5294	977
<hr/>	
5313	984 × 1
5332	984
<hr/>	
5351	991 × 1
5370	991
<hr/>	
5389	998 × 1
5408	998
<hr/>	
5427	1005 × 1
5446	1005
<hr/>	
5465	1012 × 1
5484	1012
<hr/>	
5503	1019 × 1
5522	1019
<hr/>	
5541	1026 × 1
5560	1026
<hr/>	
5579	1033 × 1
5598	1033
<hr/>	
5617	1040 × 1
5636	1040
<hr/>	
5655	1047 × 1
5674	1047
<hr/>	
5693	1054 × 1
5712	1054
<hr/>	
5731	1061 × 1
5750	1061
<hr/>	
5769	1068 × 1
5788	1068
<hr/>	
5807	1075 × 1
5826	10

## PROPOSITIO II.

*Logarithmorum Canonem Briggianum construere.*

**N**umerorum Compositorum Logarithmi derivantur ex Logarithmis Primorum componentium, per additionem solam; horum autem investigatio pluribus modis institui potest: Exemplum unicum appono.

Per Corollarium quintum Propositionis superioris, scribendo 1 pro M, inveniantur Logarithmi rationum inter 126 & 125, 225 & 224, 2401 & 2400, 4375 & 4374; qui vocentur respective  $p, q, r, s$ : & Logarithmus denarii seu rationis decupli erit  $239p + 90q - 63r - 103s$ , sive  $2,302585092994$  &c. Itaque cum Logarithmus *Briggianus* denarii sit 1; fiat (per Corol. 3. Prop. 1.) ut denarii Logarithmus modo inventus  $2,302585092994$  &c, ad Modulum suum 1, ita denarii Logarithmus *Briggianus* 1, ad Modulum *Briggianum*, qui adeo erit  $0,434294481903$  &c. Ponatur ergo deinceps iste valor pro M, & erunt  $M \times 202p + 76q - 53r + 87s$ ,  $M \times 167p + 63q - 44r + 72s$ ,  $M \times 114p + 43q - 30r + 49s$  Logarithmi *Briggiani* numerorum 7, 5, 3. Logarithmus numeri 2 habetur, subducendo Logarithmum numeri 5 à Logarithmo numeri 10. Atque ita dantur & Modulus *Briggianus* & Logarithmi Primorum omnium qui sunt minores denario.

Logarithmi numerorum sequentium Primorum 11, 13, 17, 19, 23, &c. ita computari possunt. Quæraturn tum factus à numeris Primo proposito utrinque proxime adjacentibus, tum Primi ipsius quadratum, quod semper unitate factum illud superabit. Logarithmo rationis quadrati ad factum (per Corol. 5. Prop. 1. inveniend) addatur ipsius facti Logarithmus, qui semper componetur ex datis Logarithmis Primorum qui proposito Primo sunt minores: & semisumma erit Logarithmus Primi quæsitus.

*Corol.* Canonis *Briggiani* Modulus est  $0,434294481903$  &c: Hujus vero Reciprocus est  $2,302585092994$  &c.

*Scholium.*

Ad hunc itaque modum perfici posset Logarithmorum Tabula amplissima, qualis edita est à *Briggio* vel *Vlacco*. Inventioni autem Numerorum & Logarithmorum sibi invicem congruentium, qui intermedii

termedii sunt & ultra Tabulæ limites excurrunt, abunde sufficiet terminus primus Seriei quæ in Corollario quinto Propositionis præcedentis exhibetur.

Si dato Numero intermedio quæratnr ejus Logarithmus; pone  $a$  &  $e$  pro Numero intermedio proposito atque huic proximo tabulari, ita ut  $a$  designet majorem,  $e$  minorem; sit eorum summa  $z$ , differentia  $x$ ; pone  $\lambda$  pro Logarithmo rationis quam habet  $a$  ad  $e$ , hoc est, pro excessu Logarithmi Numeri  $a$  supra Logarithmum Numeri  $e$ : & erit  $\lambda \doteq 2 M \frac{x}{z}$  quamproxime.

Si quæratnr Numerus qui congruit Logarithmo intermedio; quoniam est  $\lambda = \frac{2 M x}{z} = \frac{2 M x}{2 a - x}$  vel  $\frac{2 M x}{2 e + x}$ ; erit  $x = \frac{\lambda}{M + \frac{1}{2} \lambda} a$  vel  $\frac{\lambda}{M - \frac{1}{2} \lambda} e$  quamproxime.

### PROPOSITIO III.

*Systematis cujusvis Logometrici constructionem exponere per Canonem Logarithmorum.*

*Cas. 1.* SI detur, è Systemate proposito, mensura rationis alicujus determinatæ: rationis cujusvis oblata mensura, erit ad mensuram illam datam determinatæ rationis, ut oblata rationis Logarithmus, ad Logarithmum rationis ejusdem determinatæ.

*Cas. 2.* Si non detur, è Systemate proposito, mensura rationis alicujus determinatæ: inveniendus erit Modulus propositi Systematis, per Corollarium secundum Propositionis primæ. Et mensura cujusvis oblata rationis, erit ad Modulum inventum, ut oblata rationis Logarithmus, ad Canonis Modulum.

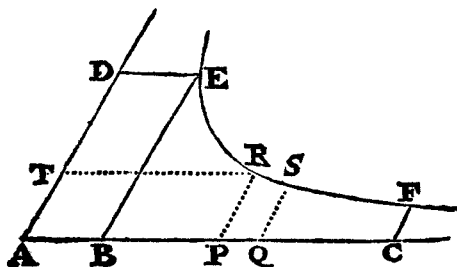
Casus hujus ultimi habentur Exempla in sequentibus.

### PROPOSITIO IV.

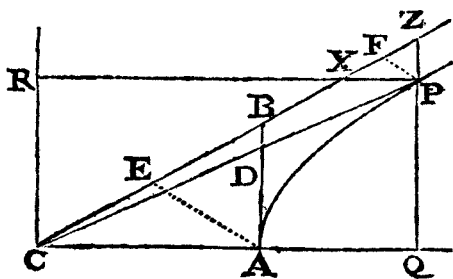
*Spatium quodvis Hyperbolicum quadrare per Canonem Logarithmorum.*

SIT Hyperbola quævis  $ERSF$  centro  $A$ , Asymptotis  $ABC$ ,  $AD$  descripta; & quæratnr area  $BEFC$  quam claudunt rectæ  $BE$ ,  $CF$  ad Asymptoton  $AD$  parallelæ. Compleatur parallelogrammum  $ABED$ , & ad hunc Modulum inveniatur (per Propositionem

fictionem tertiam) mensura rationis inter  $AC$  &  $AB$  vel inter  $BE$  &  $CF$ : Dico mensuram inventam æqualem fore magnitudini areæ quæsitæ  $BEFC$ . Nam divisa concipiatur hujus areæ basis  $BC$  in particulas innumeras quam minimas  $PQ$ , ea lege, ut ubique detur ratio illa quæ est inter  $AQ$  &  $AP$ , & ducantur Asymptoto  $AD$  parallelæ  $PR$ ,  $QS$ . Quoniam itaque est  $AQ$  ut  $AP$ ; erit divisim  $PQ$  ut  $AP$ , hoc est, ut  $PR$  reciproce. Unde data est area  $PRSQ$ , quæ proinde potest haberi pro mensura rationis datæ quæ est inter  $AQ$  &  $AP$ . Hujus autem mensuræ Modulus erit parallelogrammum  $ABED$ , per Corol. 2. Prop. 1. Nam si compleatur æquale parallelogrammum  $APRT$ ; statim intelligetur, ita illud se habere ad aream  $PRSQ$ , ut se habet  $AP$  ad  $PQ$ . Similes ergo summas arearum atque rationum utrinque colligendo; area tota  $BEFC$  erit mensura rationis totius quæ est inter  $AC$  &  $AB$ , vel inter  $BE$  &  $CF$ , ad eundem Modulum  $ABED$ .



*A'et.* Sit rursus Hyperbola quævis  $AP$ , centro  $C$  atque Asymptoto  $CB$  descripta; & quærat<sup>r</sup> area Sectoris cujuslibet  $CAP$ , semidiametris  $CA$ ,  $CP$  curvæque  $AP$  interjecti. Producta semidiametro utravis  $CAQ$  ultra verticem  $A$ , ducatur illius conjugata  $CR$ ; & ad ipsas  $CQ$ ,  $CR$  ordinatim applicentur à puncto  $P$  rectæ  $PQ$ ,  $PR$ , quæ Asymptoto  $CB$  occurrant in  $Z$  &  $X$ ; deinde agatur  $AB$  quæ Hyperbolam tangat in  $A$ , Asymptoton secet in  $B$  rectamque  $CP$  in  $D$ : & Triangulo  $ABC$  existente Modulo, area quæsitæ sectoris  $CAP$  erit mensura rationis inter  $QZ - QP$  &  $AB$ , five rationis inter  $AB$  &  $QZ - QP$ ,  
five





& erit  $v$  ad  $V$  ut  $AP$  ad  $AC$ . Sit  $AK$  ipfis  $AC$ ,  $AP$  tertia proportionalis: & erit  $r$  ad  $R$  ut  $AK$  ad  $AC$ . Ad tangentem  $AC$  erigantur normales  $CZ$ ,  $KN$ ,  $AB$ ; centroque  $C$  & Asymptotis  $CA$ ,  $CZ$  describatur Hyperbola quævis  $BN$ : & erit  $s$  ad  $S$  ut area  $ABNK$  ad rectangulum  $CKN$ . Patent hæc omnia per Propositiones octavam & nonam Libri secundi Philosophiæ *Newtonianæ*.

Est itaque  $t$  ad  $T$  ut area Hyperbolica  $DAT$  ad dimidium trianguli  $DAC$ , hoc est, ut dimidiata mensura rationis inter  $AC+AP$  &  $AC-AP$  ad illius mensuræ dimidiatum Modulum. Ergo si recta quævis  $EF$  producat ad  $f$ , ita ut  $t$  sit mensura rationis inter  $Ef$  &  $EF$  ad Modulum  $T$ , & bifecetur  $Ff$  in  $G$ : erit  $GF$  ad  $GE$  ut  $AP$  ad  $AC$ , hoc est, ut  $v$  ad  $V$ . Sumantur  $GE$ ,  $GF$ ,  $GH$  continue proportionales: & erit  $GH$  ad  $GE$  ut  $AK$  ad  $AC$ , hoc est, ut  $r$  ad  $R$ . Erit insuper  $EG$



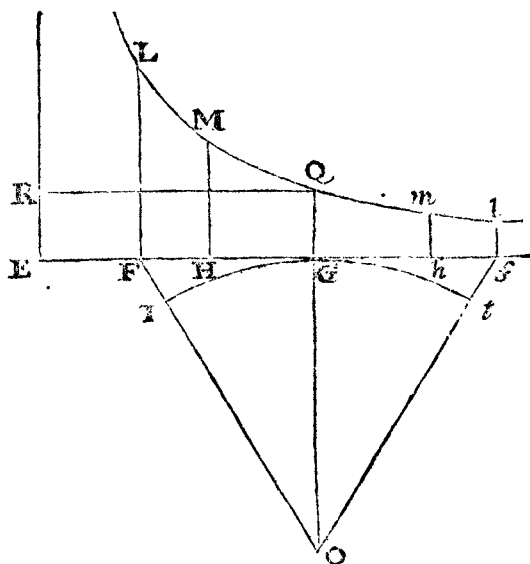
ad  $EH$  ut  $CA$  ad  $CK$ ; unde cum sit  $s$  ad  $S$  ut area  $ABNK$  ad rectangulum  $CKN$ , hoc est, ut mensura rationis inter  $CA$  &  $CK$  vel inter  $EG$  &  $EH$  ad mensuræ Modulum: erit  $s$  mensura rationis inter  $EG$  &  $EH$  ad Modulum  $S$ , atque inde dabitur.

Ex hisce porro facillime se prodit, per unicam quamvis Hyperbolam, constructio non inconcinna; quam & adscribere visum est ob dignitatem Problematis. In recta quavis  $GE$  sumatur utcumque punctum  $F$  inter  $E$  &  $G$ , & ab altera parte capiatur  $Gf$  ipsi  $GF$  æqualis, & sint  $GE$ ,  $GF$ ,  $GH$  continue proportionales. Deinde per puncta  $E$ ,  $F$ ,  $H$ ,  $G$ ,  $f$  ducantur sibi invicem parallelæ rectæ  $ER$ ,  $FL$ ,  $HM$ ,  $GQ$ ,  $fl$ , quas fecet Hyperbola quævis  $LMQl$  centro  $E$ , Asymptotis  $ER$ ,  $EG$  descripta, & compleatur parallelogrammum  $EGQR$ . Jam si sit  $t$  ad  $T$  ut area Hyperbolica  $LFfl$  ad parallelogrammum  $EQ$ : erit  $s$  ad  $S$  ut area  $MHGQ$  ad  $EQ$ ;  $v$  ad  $V$  ut  $GF$  ad  $GE$ ;  $r$  ad  $R$  ut  $GH$  ad  $GE$ .

Libet & casum alterum adjicere ubi corpus ascendit; ne forte analogia illa, quæ inter utrumque servari debet, in allata constructione quodammodo perire videatur. Ergo eadem atque prius denotantibus  $V$ ,  $R$ ,  $T$ ,  $S$ , ponantur  $v$  &  $r$  pro velocitate & resistentia sub ascensu initio,  $s$  pro spatio quod corpus ascendendo describere possit antequam tota velocitas amittatur,  $t$  pro tempore hujus ascensus. Ad  $EG$  erigatur perpendicularis  $GO$  ipsi  $EG$  æqualis, & sumendo puncta  $F$ ,  $f$  ad easdem distantias hinc inde à puncto  $G$ ,  
jun-



jungantur  $OF$ ,  $Of$ , quibus occurrat in  $T$  &  $t$  circuli arcus  $TGt$  centro  $O$  descriptus, & sint  $Gh$ ,  $Gf$ ,  $GE$  continue proportionales, & ducatur ipsi  $ER$  parallela  $hm$  Hyperbolæ occurrens in  $m$ . De-



inde si  $t$  sit mensura anguli  $FOf$  ad Modulum  $T$ , hoc est, si  $t$  sit ad  $T$  ut arcus  $TGt$  ad radium  $OG$ : erit  $s$  mensura rationis inter  $Eh$  &  $EG$  ad Modulum  $S$ , vel erit  $s$  ad  $S$  ut area Hyperbolica  $mhGQ$  ad  $EQ$ ; &  $v$  erit ad  $V$  ut  $Gf$  ad  $GE$ ; atque  $r$  ad  $R$  ut  $Gh$  ad  $GE$ .

## PROPOSITIO V.

*Logisticam describere per Canonem Logarithmorum.*

SI ad Logisticæ  $BQDG$  Asymptoton  $APCF$  ordinatim applicentur binæ quævis rectæ  $AB$ ,  $FG$  intercludentes Asymptoti portionem quamvis  $AF$ : erit illa portio mensura rationis quam ad invicem habent ordinatæ; hæc utique est natura Curvæ notissima. Integrum ergo & perfectum Systema Logometricum per hanc Lineam exhibetur: id quod etiam de Hyperbola dici potest per Propositionem præcedentem, de Spirali Æquiangula per subsequentem;

nam

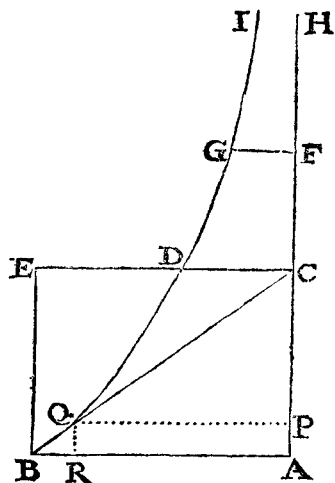
nam omitto complures alias Figuras, quæ & ipsæ dudum sunt in Geometriam receptæ. Itaque si detur Asymptoti positio & simul duo puncta per quæ Curva transire debet, dabuntur puncta reliqua per casum priorem Propositionis tertiæ. Quod si data positione Asymptoti, detur insuper Systematis Modulus atque unicum punctum per quod ducenda erit Curva; invenientur puncta reliqua per Casum posteriorem Propositionis ejusdem. Iste vëro Modulus quo pacto definiendus sit, & qualem habeat magnitudinem, jam oportet exponere.

Ducatur recta  $BC$  quæ Curvam tangat in  $B$  & Asymptoton fecerit in  $C$ . Dico primo, magnitudinem subtangentis  $AC$  eandem permanere ubicunque sumatur punctum  $B$ . Intelligatur enim Ordinata  $PQ$  vicinissima Ordinatæ  $ARB$ , recta vero  $QR$  parallela Asymptoto  $AC$ , ac detur Ordinarum intervallum illud quam minimum  $AP$ . Ob datam igitur lineolam  $AP$ , dabitur ratio quam habet  $AB$  ad  $PQ$ , & divisim ratio quam habet  $AB$  ad  $RB$ , atque adeo (propter similia triangula  $BAC$ ,  $BRQ$ ) ratio quam habet  $AC$  ad  $RQ$  sive  $AP$ , atque inde magnitudo ipsius  $AC$ .

Dico secundo, determinatam hanc & immutabilem subtangentem  $AC$ , esse Modulum ad quem exigendæ sunt mensuræ illæ interceptæ  $AF$ . Patet hoc per Corollarium secundum Propositionis primæ: nam dum termini  $AB$  &  $PQ$  ad æqualitatem proxime accedunt, erit  $AC$  ad  $AP$ , quæ metitur rationem inter  $AB$  &  $PQ$ , ut terminus  $AB$  ad terminorum differentiam  $BR$ . Unde data subtangente, facilis est descriptio Curvæ & solutio Problematum omnium quæ ex hinc pendent.

Si Curva jam descripta habeatur, subtangentis magnitudo sic determinabitur. Producaturs Ordinata quævis  $CD$  ad  $E$ , ita ut  $CE$  ad  $CD$  rationem habeat Modularem, per Corollarium sextum Propositionis primæ definitam; & recta  $EB$  quæ à puncto  $E$  parallela ducitur Asymptoto, quæque Curvæ occurrit in puncto  $B$ , æqualis erit subtangenti quæsitæ.

*Corol.*



*Corol. 1.* Area  $ABIH$ , quæ inter Curvam  $BDI$  & Asymptoton ejus  $ACH$  infinite versus  $HI$  extenditur, & ad alteram partem ab Ordinata  $AB$  terminatur, æqualis est parallelogrammo  $ABEC$  ab Ordinata eadem  $AB$  & subtangente  $AC$  comprehenso. Componuntur enim area & parallelogrammum ex elementis quæ sunt ut  $AP \times AB$  &  $AC \times RB$ , quæque adeo æquantur propter analogiam inter  $AP$  &  $RB$ ,  $AC$  &  $AB$ .

*Corol. 2.* Atque hinc, ob datam subtangentis magnitudinem, area illa indefinita erit ut Ordinata ad quam terminatur.

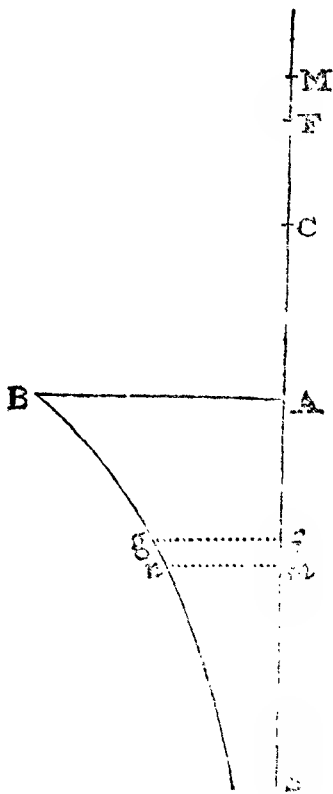
### *Scholium.*

Hujus Propositionis usus per Exemplum declarabitur. Proponatur ad quamlibet altitudinem à superficie telluris, invenire densitatem Atmosphæræ. Sit  $AB$  telluris superficies, & abinde sursum producat perpendicularis  $AH$ , acque ad hujus puncta singula ductæ concipiantur Ordinatæ  $FG$ , quæ sint ut Aeris densitates in locis  $F$ ; & Ordinatarum termini omnes  $G$  in Linea Logistica  $BDGI$  sit erunt. Patet hoc per Corollarium secundum hujus Propositionis. Nam area indefinita  $FGIH$  est ut quantitas seu pondus Atmosphæræ supra locum  $F$ ; & pondus illud est vis quæ comprimit Aerem in hoc loco, isthæc vero vis (uti docet Experientia multiplex) est ut Aeris compressi densitas  $FG$ .

Itaque si quotlibet altitudines sumantur in Arithmetica progressionem: densitates Aeris in his altitudinibus erunt in progressionem Geometricam; & differentia binarum quarumvis altitudinum, erit mensura rationis quæ est inter densitates Aeris in istis altitudinibus.

Cessante vi gravitatis, ita jam per vim aliquam extraneam intelligatur Aeris facta compressio, ut eandem habeat ubique densitatem quam ad terræ superficiem; & quantitas ejus, quæ modo erat exposita per aream indefinitam  $HABI$ , nunc per æquale rectangulum  $ABEC$  exhibebitur. Atmosphæræ hujus homogeneæ altitudo  $AC$ , est ad altitudinem Hydrargyri in tubo *Torricellii*, ut gravitas Hydrargyri ad gravitatem Aeris; atque inde datur. Huic autem datæ altitudini æquatur (per Corol. 1.) subtangens Curvæ  $BDGI$ , atque adeo Modulus Systematis mensurarum omnium  $AF$ . Est ergo Logarithmus rationis inter densitates Aeris in binis quibusvis altitudinibus, ad Modulum Canonis, ut altitudinum earundem differentia, ad Atmosphæræ prædictæ homogeneæ altitudinem illam datam  $AC$ .

Hæc ita se habent ex Hypothesi, quod vis gravitatis eadem sit ad omnes altitudines. Ceterum ex Philosophia *Newtoniana* constat eam diminui, in recessu à centro telluris, in duplicata ratione distantia: conclusio itaque paulo aliter se habebit. Sit  $S$  centrum telluris, &  $AB$  superficies ejusdem; sumatur ipsis  $SF$ ,  $SA$  tertia proportionalis  $Sf$ , erigatur ordinata  $fg$  quæ sit ut Aeris densitas in  $F$ : & Curva  $Bgn$  quam punctum  $g$  perpetuo tangit, erit eadem atque prius Logistica, sed inverso situ. Augeatur enim altitudo  $AF$  particula quam minima  $FM$ , capiatur  $Sm$  ad  $SA$  ut  $SA$  ad  $SM$ , ducatur Ordinata  $mn$  quæ sit ut Aeris densitas in  $M$ ; & erit  $Sm$  ad  $Sf$  ut  $SF$  ad  $SM$ , & divisim  $fm$  ad  $FM$  ut  $Sf$  ad  $SM$ , five ut  $Sf$  ad  $SF$ , hoc est, ut  $SAq$  ad  $SFq$ . Unde  $fm$  est ut  $SFq$  inverse &  $FM$  directe, id est, ut gravitatio & moles Aeris inter  $F$  &  $M$  conjunctim; adeoque  $fm \times fg$  five area  $fgnm$  est ut gravitatio, moles & densitas ejusdem Aeris conjunctim, hoc est, ut pressio illius in Aerem inferiorem: & summa similium omnium arearum infra  $fg$  est ut summa pressionum omnium supra  $F$ , id est, ut Aeris in  $F$  densitas  $fg$ : & summarum differentia  $fgnm$  ut densitatum differentia  $fg - mn$ . Detur lineola  $fm$ ; & erit  $fg$  ut area  $fgnm$ , adeoque ut  $fg - mn$ , atque inde (componendo) ut  $mn$ . Ergo data lineola  $fm$  erit mensura datæ illius rationis quæ est inter  $fg$  &  $mn$ ; atque hinc patet Curvam  $Bgn$  esse Logisticam. Sed & eandem esse cum supra descripta Logistica, facile abinde colligitur, quod ordinatæ basi  $AB$  vicinissimæ & ad æqualia intervalla quam minima dispositæ, respectivé sint æquales in utraque Curva; ac proinde eadem curvatura, eadem inclinatio tangentis ad punctum  $B$ , eademque subtangentis magnitudo.



Ergo

Ergo si distantia  $SF$  à centro telluris, capiantur in Musica progressionē; harum reciproca, nempe distantia  $Sf$ , erunt in progressionē Arithmetica; & Aeris densitates  $fg$  erunt in progressionē Geometrica.

Ad inveniendam itaque densitatem in loco quovis  $F$ , minuenda est altitudo  $AF$  in ratione distantia  $SF$  ad telluris semidiametrum  $SA$ : & Logarithmus rationis inter densitates Aeris in  $A$  &  $F$ , erit ad Modulum Canonis, ut altitudo illa diminuta  $Af$ , ad Atmosphæræ homogeneæ altitudinem  $AC$ .

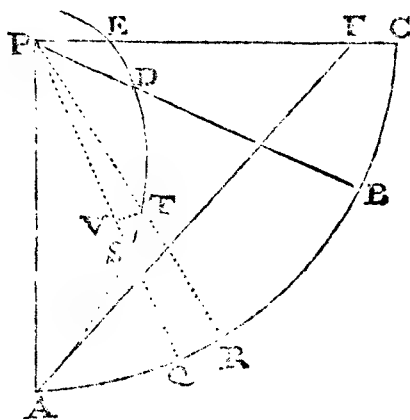
Quæ supra demonstrata sunt, accurate obtinebunt, si modo Atmosphæra ex Aere pariter Elastico rota constet: rationes igitur allatas paululum conturbabunt admisti vapores atque exhalationes, quibus etiam accedet Caloris Frigorisque diversa temperies ad altitudines diversas.

## PROPOSITIO VI.

*Logarithmorum Canonem ad Spiralem Equiangulam accomodare.*

**Æ**Quiangula Spiralis appellatur Linea illa curva  $ADE$ , quæ polo  $P$  descripta, in eodem dato angulo secat exeuntes à polo radios  $PA$ ,  $PD$ ,  $PE$ , &c.

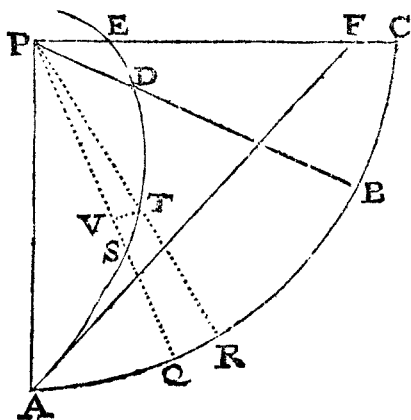
Si centro  $P$  & intervallo quovis  $PA$  describatur circulus  $ABC$ , qui radiis  $PA$ ,  $PD$ ,  $PE$  occurrat in  $A$ ,  $B$ ,  $C$ : Dico interceptum arcum  $BC$  mensuram fore rationis quam habet  $PD$  ad  $PE$ , & interceptum arcum  $AB$  mensuram rationis quam habet  $PA$  ad  $PD$ . Dividatur enim arcus  $AB$  in particulas quam minimas & æquales  $QR$ , & jungantur  $PQ$ ,  $PR$  secantes Spiralem ad  $S$  &  $T$  in angulis datis  $PST$ ,  $PTS$ : & ob datam particulam  $QR$ , dabitur



angulus  $QPR$ , atque adeo species Figuræ  $SPT$ , & ratio laterum  $PS$ ,  $PT$ . Data ergo particula  $QR$  mensura erit rationis datæ quam  
D 2
habet

habet  $PS$  ad  $PT$ ; & summa particularum, nempe arcus  $AB$ , mensura erit summæ similis rationum, hoc est, rationis quam habet  $PA$  ad  $PD$ . Et eodem argumento, erit arcus  $BC$  mensura rationis quam habet  $PD$  ad  $PE$ .

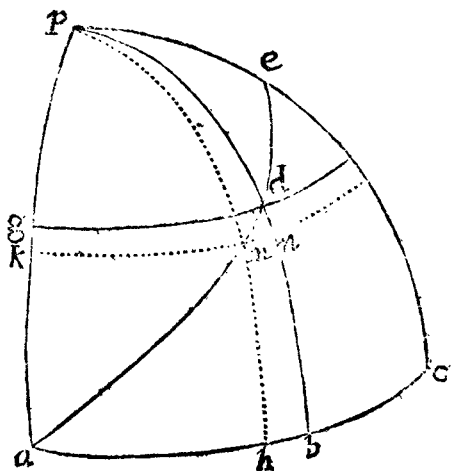
Ducatur  $AF$  Spiralem tangentem ad Circuli & Spiralis intersectionem  $A$ , huic vero in  $F$  occurrat recta  $PC$  quæ ad radium  $PA$  normalis erigitur: & subtangens  $PF$  erit mensurarum Modulus, per Corol. 2. Prop. 1. Nam si in recta  $PS$  sumatur  $PV$  ipsi  $PT$  æqualis, & jungantur puncta  $V, T$ ; similia erunt triangula  $PAF, VST$ . Unde  $PF$  est ad  $VT$  ut  $PA$  ad  $VS$ , sed &  $VT$  est ad  $QR$  ut  $PT$  ad  $PA$ : ergo ex æquo perturbate,  $PF$  est ad  $QR$  quæ metitur rationem inter  $PS$  ad  $PT$ , ut terminus  $PT$  ad terminorum Differentiâ  $VS$ .



### Scholium.

Spiralem æquiangulam, ad Meridianæ Nauticæ divisionem demonstrandam, feliciter adhibuit Geometra clarissimus *Edmundus Halleius*. Sit  $acp$  pars octava Sphæræ terrestris,  $p$  Polus,  $ac$  quadrans Æquatoris,  $ap$  quadrans Meridiani; & quærat magnitudo rectæ, quæ propositum quemlibet hujus arcum designet in Planisphærio. Per Æquatoris & Meridiani intersectionem  $a$ , ducta intelligatur linea Helicoeides  $ade$  quæ secet omnes Meridianos ad angulum semirectum, huic occurrat in  $d$  parallelus Æquatori circulus  $gd$ , per idem punctum  $d$  agatur Meridianus  $pdb$ ; & longitudo intercepti arcus Æquatoris  $ab$ , erit magnitudo Nautica quæsitæ arcus  $ag$ . Resolvatur enim arcus  $ag$  in particulas innumeras quam minimas  $gk$ , ducatur parallelus  $kmn$ , focans Meridianum  $pdb$  in  $n$ , Lineam  $ade$  in  $m$ ; & actus Meridianus  $pmb$  abscindet Æquatoris particulam  $bh$ , quæ erit ad  $mn$ , sive huic (ob angulum semirectum  $mdn$ ) æqualem  $dn$  vel  $gk$ , ut peripheria Æquatoris ad peripheriam paralleli  $kmn$ . Est ergo particula  $bh$  magnitudo Nautica particulæ  $gk$ , & summa particularum omnium  $bh$ , nempe longitudo arcus  $ab$ , magnitudo Nautica

tica summæ particularum omnium  $gk$ , id est, arcus  $ag$ . Manente jam *Æquatore*  $abc$  vel  $ABC$ , concipiatur Sphærica superficies in plano ejus Stereographice depingi; & Polo  $p$  occupante centrum  $P$ , projicientur Meridiani  $pga$ ,  $pdb$ ,  $pcc$  in totidem rectas  $PA$ ,  $PDB$ ,  $PEC$  à centro  $P$  exeuntes, ita ut distantia abinde puncti cujusvis  $D$  vel  $A$ , tangens sit arcus dimidiati  $pd$  vel  $pa$  quem distantia illa repræsentat. Linea vero Helicocides  $ade$  convertet se in Spiralem æquiangulam  $ADE$ , polo  $P$  descriptam, & tangentem radios suos omnes ad angulum semi-rectum. Hoc siquidem postulat nota Lex hujusce Projectionis, ut anguli omnes eandem in Plano ac in Sphærica superficie magnitudinem servant. Arcus itaque propositi  $ag$  magnitudo Nautica  $ab$  vel  $AB$ , est



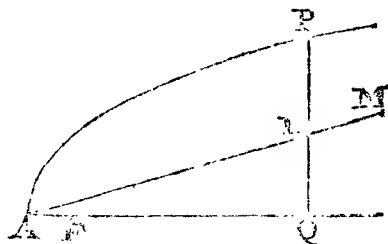
ad subtangentem  $PF$  vel huic jam æqualem Sphæræ radiûm  $PC$ , ut Logarithmus rationis inter  $PA$  &  $PD$ , hoc est, inter tangentes dimidiatorum arcum  $pa$  &  $pd$ , vel  $pa$  &  $pg$ , ad Modulûm Canonis.

Hinc quoniam longitudo Radii est ad longitudinem arcus minuti unius primi, ut 3437,746772784939 &c ad 1, & reciprocus Moduli Canonis est 2,302585092994 &c, atque hi numeri in se multiplicati efficiunt 7915,704467897819 &c: si magnitudo illa Nautica  $AB$  in minutis primis exhibenda sit, uti mos exigit; subducta tangente artificiali dimidiati arcus  $pg$  à tangente artificiali dimidiati arcus  $pa$ , multiplicetur residuum per numerum 7915,704467897819 &c, et factus dabit partes Meridionales desideratas. Perinde vero se habebit conclusio, siue in *Æquatore*, siue extra hunc alibi ad utramvis partem locetur punctum  $a$ .

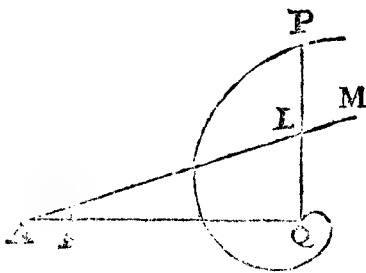
## SCHOLIUM GENERALE.

**I**N eum potissimum finem præcedentia conscripsi, ut allatis aliquot Exemplis ostenderem, qua commodissima ratione Logarithmorum usus in Geometriam recipi, & ad resolutionem Problematum difficiliorum adhiberi possit. Visum est hoc loco nonnullas adjicere porro constructiones, eodem consilio effectas, quæ mihi ista tractanti subinde sese obviam non invitæ dederunt: ut ita, ex uberiore specimine, de præstantia Methodi hujus Logometricæ judicium feratur.

Parabolæ *Apolloniana*  $AP$  sit  $A$  vertex,  $F$  focus,  $AQ$  axis,  $PQ$  ordinatim applicata ad axem. Ducatur  $AL$  quæ bifariam secet  $PQ$  in  $L$ , & productæ adjiciatur  $LM$  quæ sit mensura rationis inter  $LA + AQ$  &  $QL$  ad Modulum  $AF$ : & recta  $AM$  æqualis erit arcui Parabolico  $AP$ .



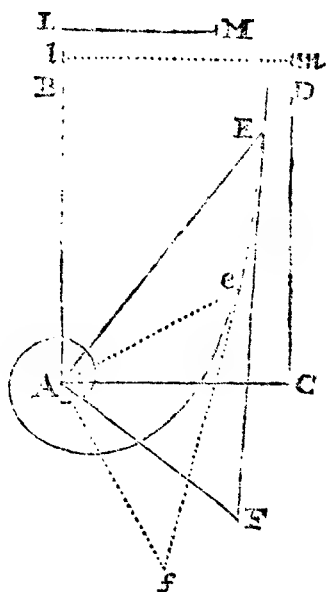
Spiralis *Archimedeæ*  $PQ$  similem habet extensionem in rectam. Sit  $Q$  polus ejus,  $QP$  radius à polo ductus ad Curvæ quodlibet punctum  $P$ , & ad eum radium normalis  $QA$ . Ducatur  $LA$  parallela tangenti Spiralem in  $P$ , quæ radium  $PQ$  bifariam secet in  $L$ ; & ponendo  $AF$  ad  $QL$  ut  $QL$  ad  $QA$ , ipsi  $AL$  adjiciatur  $LM$  quæ sit mensura rationis inter  $LA + AQ$  &  $QL$  ad Modulum  $AF$ : & recta  $AM$  æquabitur Spiralis arcui  $PQ$ .



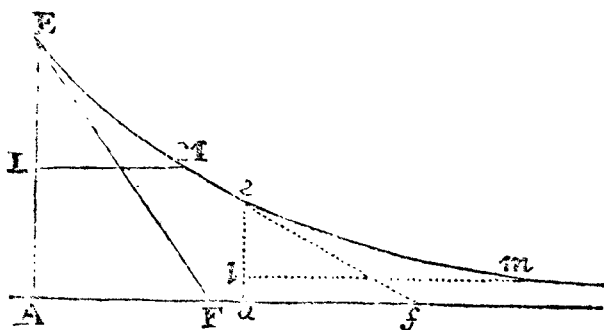
Spiralis Reciprocae  $AeE$  sit  $A$  polus,  $AB$  radius primus & infinitus,  $CD$  asymptotos radio primo parallela ad distantiam  $AC$ ; & invenienda proponatur hujusce Curvæ longitudo. Inter Spiralem illam vulgarem *Archimedis* atque hanc, quam Reciprocam appello, isthæc intercedit differentia, quod cum illius radii sint ut anguli quos faciunt cum radio suo primo, hujus radii è contrario sunt



sunt reciproce ut iidem anguli: eandem utique proportionem habet radius  $AE$  ad radium  $Ae$  quam habet angulus  $eAB$  ad angulum  $EAB$ . Unde facile colligitur, si ad puncta  $E$  &  $e$  ducantur tangentes  $EF$ ,  $ef$ , & ad radios  $AE$ ,  $Ae$  erigantur normales  $AF$ ,  $Af$ , fore normales istas sibi invicem & Asymptoti intervallo  $AC$  æquales. Invenitur autem longitudo cujusvis arcus  $Ee$ , ponendo  $LM$  mensuram rationis inter  $AE$  &  $EF - AF$  ad Modulum  $AF$ , & similiter  $lm$  mensuram rationis inter  $Ae$  &  $ef - Af$  ad æqualem Modulum  $Af$ . Nam si tangentium differentię  $EF - ef$  adjiciatur mensurarum differentia  $lm - LM$ , aggregatum æquabitur arcui  $Ee$ .



Linea illa Logistica, cujus aliquas exposuimus affectiones in Propositione quinta, non absimilem habet longitudinis suę determinationem; quam & hoc loco apponam in eorum gratiam qui hujus-



modi contemplationibus delectantur. Oblata sit igitur Logistica  $EMem$ , cujus Asymptotos  $AFaf$ : & quæratur longitudo cujusvis arcus  $Ee$ . Demissis in Asymptoton perpendiculis  $ELA$ ,  $ela$ , &





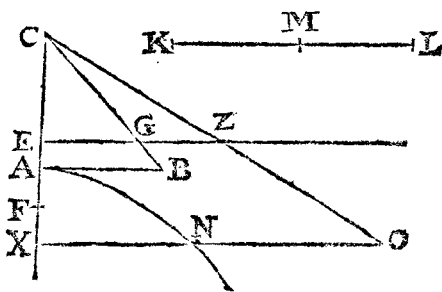
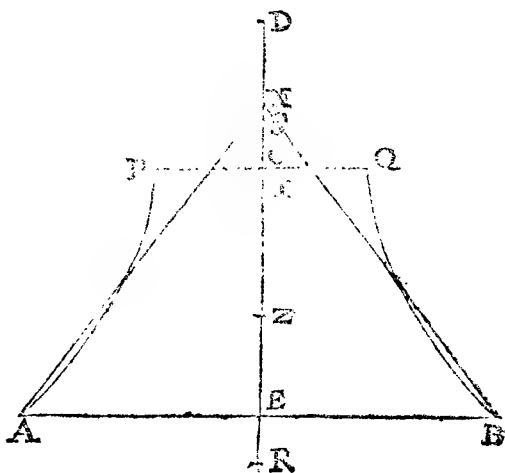
producta fumantur  $CR$  ad  $CD$ , &  $CD$  ad  $CS$ , ut basi  $AB$  ad diametrum  $PQ$ , & ad Modulum  $CS$  fiat  $CN$  mensura rationis quam habet  $CD$  ad  $ER$ : triangulum rectilineum  $ANB$  æquabitur areæ curvilinæ  $ADB$ .

Hujus autem areæ centrum gravitatis  $Z$  invenietur, capiendo  $CZ$  ad  $CR$  ut  $2CR$  ad  $3EN$ .

Sit nunc oblata portio exterior  $APQB$ , interclusa curvis oppositis  $AP$ ,  $BQ$ , diametro  $PQ$ , & rectæ cuius  $AB$  ad diametrum illam parallelæ. Esto  $CD$  conjugatæ semidiametri longitudo extra portionem oblata  $APQB$  posita, quæ producta in contrariam partem centri  $C$  bifariam secet basim  $AB$  in  $E$ . Deinde in diametro producta si fumantur  $CR$  ad  $CD$ , &  $CD$  ad  $CS$ , &  $CS$  ad  $CT$ , ut basi  $AB$  ad diametrum  $PQ$ , ponantur vero  $CR$  &  $CT$  ad eandem centri partem cum basi  $AB$ ; & ad Modulum  $CS$ , in contrariam centri partem, fumatur  $CN$  mensura rationis quam habet  $CD$  ad  $ER$ : triangulum rectilineum  $ANB$  æquabitur areæ curvilinæ  $APQB$ .

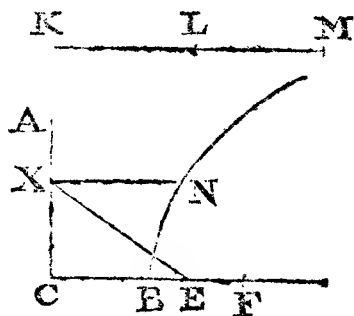
Hujus autem areæ centrum gravitatis  $Z$  invenietur, capiendo  $CZ$  ad  $CR$  ut  $2TR$  ad  $3EN$ .

Pergo ad superficies ab Hyperbola circum axes suos convoluta genitas. Sit  $AN$  Hyperbola descripta vertice  $A$ , centro  $C$ , Asymptoto  $CB$ , foco  $F$ , semiaxe principali  $AC$ , semiaxe conjugato  $AB$  normali ad  $AC$ ; & ad axis  $AC$  punctum quodvis  $X$  sit  $XN$  ordinatim applicata, quæ Hyperbolæ occurrat ad  $N$ .

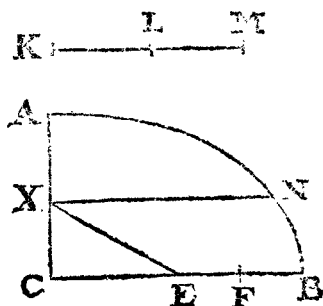


In axe  $CA$  capiatur  $CE$  ad  $CA$  ut  $CA$  ad  $CF$ ; & ad eundem axem erecta perpendiculari  $EZ$ , quæ Asymptoto occurrat in  $G$ , angulo  $CEZ$  inscribatur æqualis ipsi  $CX$  recta  $CZ$ , quæ porro producta secet ordinatim applicatam  $XN$  ad  $O$ . Tum sumatur  $KL$  quæ sit æqualis excessui quo  $XO$  superat  $AB$ , atque  $LM$  quæ sit mensura rationis inter  $CZ + ZE$  &  $CG + GE$  ad Modulum  $CE$ : & superficies genita ex arcus  $AN$  conversione circum axem  $AX$ , erit ad Circulum semidiametro  $AB$  descriptum, ut excessus  $KM$  quo  $KL$  superat  $LM$ , ad semidiametrum illam  $AB$ .

Sit rursus  $BN$  Hyperbola descripta vertice  $B$ , centro  $C$ , foco  $F$ , semiaxe principali  $CB$ , semiaxe conjugato  $CA$  normali ad  $CB$ ; & ad axis  $AC$  punctum quodvis  $X$  sit  $XN$  ordinatim applicata, quæ Hyperbolæ occurrat ad  $N$ . In axe  $CB$  capiatur  $CE$  ad  $CA$  ut  $CA$  ad  $CF$ , & jungatur  $EX$ . Tum sumatur  $KL$  quæ sit ad  $XC$  ut  $XE$  ad  $CE$ , &  $LM$  quæ rationis inter  $EX + XC$  &  $CE$  mensura sit ad Modulum  $CE$ : & superficies genita ex arcus  $BN$  conversione circum axem  $CX$ , erit ad Circulum semidiametro  $CB$  descriptum, ut linearum  $KL$  &  $LM$  aggregatum  $KM$ , ad semidiametrum illam  $CB$ .

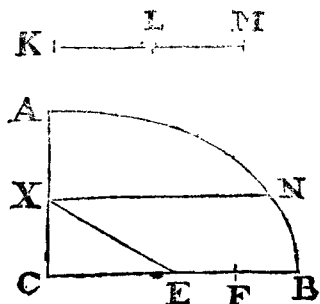


His addere licebit ab Ellipfi genitas superficies. Sit  $ANB$  Ellipsis descripta centro  $C$ , verticibus  $A$  &  $B$ , foco  $F$ , semiaxe principali  $CB$ , semiaxe conjugato  $CA$ ; & ad axis  $CA$  punctum quodvis  $X$  sit  $XN$  ordinatim applicata, quæ Ellipfi occurrat ad  $N$ . In axe  $CB$  capiatur  $CE$  ad  $CA$  ut  $CA$  ad  $CF$ , & jungatur  $EX$ . Tum sumatur  $KL$  quæ sit ad  $XC$  ut  $XE$  ad  $CE$ , &  $LM$  quæ rationis inter  $EX + XC$  &  $CE$  mensura sit ad Modulum  $CE$ : & superficies genita ex arcus  $BN$

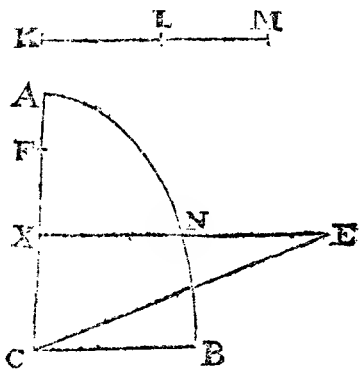


conversione circum axem  $CX$ , erit ad Circulum semidiametro  $CB$  descriptum, ut linearum  $KL$  &  $LM$  aggregatum  $KM$ , ad semidiametrum illam  $CB$ . Ut hæc ultima constructio locum habeat, oportet semiaxem  $CA$  circa quem conversio facta est, minorem esse altero semiaxe  $CB$ ; aliter enim Mo-

duli  $CE$  quantitas  $\frac{CAq}{\sqrt{CBq - CAq}}$  evadet impossibilis, & constructio illa Logometrica (quod in hujusmodi casibus fieri solet) convertet se in Trigonometricam, qualis illa est quæ jam sequitur.



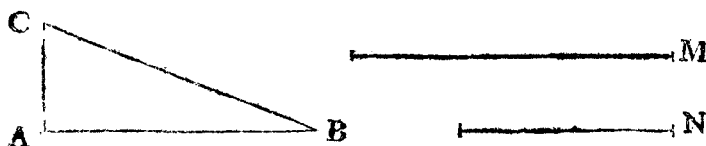
Sit  $ANB$  Ellipsis descripta centro  $C$ , verticibus  $A$  &  $B$ , foco  $F$ , semiaxe principali  $CA$ , semiaxe conjugato  $CB$ ; & ad axis  $CA$  punctum quodvis  $X$  sit  $XN$  ordinatim applicata, quæ Ellipsi occurrat ad  $N$ . Angulo  $CXN$  inscribatur recta  $CE$ , quæ sit ad  $CA$  ut  $CA$  ad  $CF$ . Tum sumatur  $KL$  quæ sit ad  $XC$  ut  $XE$  ad  $CE$ , &  $LM$  quæ anguli  $XEC$  mensura sit ad Modulum  $CE$ , hoc est, quæ sit æqualis arcui cujus sinus est  $XC$  ad radium  $CE$ : & superficies genita ex arcus  $BN$  conversione circum axem  $CX$ , erit ad Circulum semidiametro  $CB$  descriptum, ut linearum  $KL$  &  $LM$  aggregatum  $KM$ , ad semidiametrum illam  $CB$ . Posset hujus etiam superficies dimensio per Logometriam designari, sed modo inexplicabili. Nam si quadrantis circuli quilibet arcus, radio  $CE$  descriptus, sinum habeat  $CX$  sinumque complementi ad quadrantem  $XE$ : sumendo radium  $CE$  pro Modulo, arcus erit rationis inter  $EX + XC\sqrt{-1}$  &  $CE$  mensura ducta in  $\sqrt{-1}$ . Verum isthæc aliis, quibus operæ pretium videbitur, diligentius excutienda relinquo. Ceterum ex præcedentibus intelligi potest, quanta sit cognatio inter angularum atque rationum mensu-



menfuras, quamque levi mutatione in fe invicem facillime convertantur pro variis ejusdem Problematis cafibus. De Cubicarum æquationum radicibus dudum ab Analyftis obfervatum eft; vel eas exprimi poffe per *Cardani* regulas, atque adeo per duarum mediarum proportionalium inventionem; vel per divifionem arcus circularis in tres æquales partes, fi forte fuerint inexplicabiles per memoratas regulas. \* Hoc animadvertit *Cartefius*, fed & ante *Cartefium* idem obfervavit *Francifcus Vieta* sub finem Supplementi Geometriæ. Exhinc autem aperte colligitur, qualis fit ordo Naturæ tranfeuntis ad Anguli trifectiorem à trifectiione Rationis.

Mirabilem illam Harmoniam ulterius declarare lubet, Exemplo defumpto ab eadem Figura circum axes fuos convoluta. Sit igitur *APBQ* Ellipfis, axis ejus major *AB*, minor *PQ*, centrum *C*, focus *F*. Hæc circum axem utrumvis convoluta Solidum generet, cujus particulæ constantes ex materia homogænea, vires attractivas habeant in duplicata diftantiarum ratione decrefcentes: & quæratervis qua Solidum illud attrahit corpusculum quodvis, in ejus super-

\* Sublato etenim termino fecundo, tres habentur Æquationum cafus. Hi verò refolvuntur ope trianguli rectanguli *ABC*, rectum habentis angulum ad *A*, in quo infuper triangulo femper data funt duo latera.



*Caf. 1.* Nam fi fit  $x^3 + 3aax = \pm 2aab$ : ponantur  $AB = a$ ,  $AC = b$ ; & fumantur *M* & *N* binæ mediæ proportionales inter  $BC + AC$  &  $BC - AC$ : & erit  $M - N$  radix unica poffibilis affirmativa, fi habeatur  $+ 2aab$ ; vel  $N - M$  radix unica poffibilis negativa, fi habeatur  $- 2aab$ .

*Caf. 2.* Si fit  $x^3 - 3aax = \pm 2aab$ , existente *a* minore quam *b*: ponantur  $AB = a$ ,  $BC = b$ ; & fumantur *M* & *N* binæ mediæ proportionales inter  $BC + AC$  &  $BC - AC$ : & erit  $M + N$  radix unica poffibilis affirmativa, fi habeatur  $+ 2aab$ ; vel  $- M - N$  radix unica poffibilis negativa, fi habeatur  $- 2aab$ .

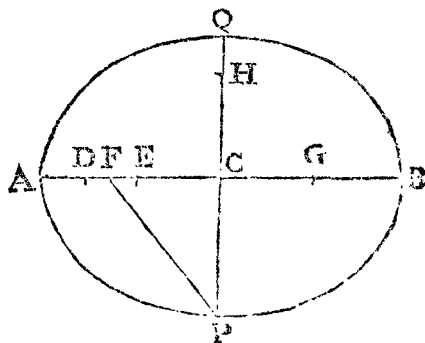
*Caf. 3.* Denique fi fit  $x^3 - 3aax = \pm 2aab$ , existente *a* majore quam *b*: ponantur  $AB = b$ ,  $BC = a$ ; & fumatur *M* finus trientis angulorum summæ  $A + B$ , atque *N* finus trientis angulorum differentiæ  $A - B$ , existente radio  $2BC$ : & erunt  $-M$ ,  $-N$ , &  $M + N$  tres radices poffibiles, fi habeatur  $+ 2aab$ ; vel *M*, *N*, &  $-M - N$  tres radices poffibiles, fi habeatur  $- 2aab$ .

Atque ita Problemata omnia Solida folutionem facilem recipiunt, vel per Canonem Logarithmicum, vel per Canonem Trigonometricum.

ficie

ficie locatum ad axis illius terminum. Jungantur puncta  $P, F$ , ac fumatur  $CD$  quæ fit mensura rationis inter  $PF + FC$  &  $CP$  ad Modulum  $CA$ , pariterque fumatur  $CE$  quæ fit anguli  $CPF$  mensura ad Modulum  $CP$ ; sitque  $FD$  excessus mensuræ  $CD$  supra  $CF$ , atque  $FE$  excessus ipsius  $CF$  supra mensuram  $CE$ : & Solidi

convolutione circum axem majorem  $AB$  geniti vis in corpusculum ad  $A$  locatum, erit ad Sphæræ homogeneæ & eodem axe descriptæ vim in idem corpusculum, ut  $\frac{3}{2}FD \times CP$  ad  $CF \times CB$ ; Solidi autem conversione circum axem minorem  $PQ$  geniti vis in corpusculum ad  $P$  locatum, erit ad Sphæræ homogeneæ & eodem axe descriptæ vim in idem corpusculum, ut  $\frac{3}{2}FE \times CA$  ad  $CF \times CB$ .



Unde cum vis Sphæræ prioris in corpusculum ad  $A$ , sit ad vim Sphæræ posterioris in corpusculum ad  $P$ , ut  $CA$  ad  $CP$ : erit vis Solidi prioris in corpusculum ad  $A$ , ad vim Solidi posterioris in corpusculum ad  $P$ , ut  $\frac{3}{2}FD \times CP$  ad  $\frac{3}{2}FE \times CA$ .

Hinc quoniam Solidum posterius medium est proportionale inter Solidum prius & Sphæram priorem: vis Solidi posterioris in corpusculum ad  $A$ , erit media proportionalis quamproxime inter vires Solidi prioris & Sphæræ prioris in idem corpusculum ad  $A$ , si modo axes Ellipseos sint prope æquales. Itaque in hoc casu, ponendo  $CG$  mediam proportionalem inter  $CF$  &  $\frac{3}{2}FD$ , & capiendo  $CH$  ad  $\frac{3}{2}FE$  ut  $CA$  ad  $CF$ ; posterioris Solidi vires ad  $A$  &  $P$ , vel ad  $B$  &  $Q$ , erunt ad invicem quamproxime ut  $CG$  ad  $CH$ . Id quod non inutile præbet compendium ad inventionem Figuræ Telluris, qualem eam subtiliter instituit celeberrimus *Newtonus*, summus ille Philosophiæ sanioris Instaurator.

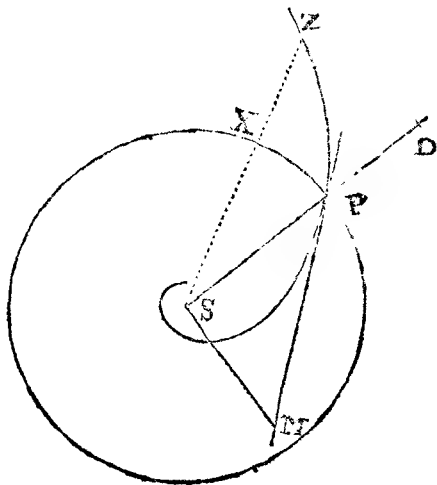
Consideratio virium centripetarum aliud porro mihi suggerit Exemplum, in quo satis ampla se prodit mutationum varietas. Proponatur Trajectoriarum species enumerare, in quibus corpora moveri possunt, quæ à viribus centripetis in ratione distantiarum triplicata decrefcentibus agitantur, quæque de loco dato, cum data velocitate, secundum datam rectam egrediuntur.





revolvi posset, ut  $\sqrt{SCq - SPq}$  ad  $SC$ . Ex ipsa constructione patet, hanc Spiralem primam infinitis gyris circa centrum virium con-  
torqueri, quin & seipsam infinitis vicibus decussare, & siti erunt  
Nodi omnes ad Apfidis lineam  $AS$ .

*Caf. 2.* Recedat punctum  $C$  ad infinitam distantiam à centro  $S$ ;  
& corporis de loco  $P$  secundum rectam  $PM$  vel  $MP$  exeuntis ea  
sit velocitas, quam acquirere posset cadendo libere ad eundem locum  
 $P$  ab infinita distantia. Ad rectam  $SP$  ducatur normalis  $SM$ , quæ  
fecet  $PM$  in  $M$ ; deinde centro  $S$  & intervallo  $SP$  describatur  
circulus, & in ejus circumferentia capiatur arcus  $PX$ , cujus longi-  
tudo sit mensura rationis in-  
ter distantiam quamvis  $SD$   
& distantiam datam  $SP$  ad  
Modulum  $SM$ , jaceant au-  
tem arcus ille  $PX$  & pun-  
ctum  $M$  ad diversas partes  
rectæ  $SP$  si  $SD$  fuerit ma-  
jor quam  $SP$ , aliter ad eas-  
dem, inque semidiametro  
 $SX$  ponatur  $SZ$  æqualis ipsi  
 $SD$ ; & punctum  $Z$  erit  
ad Trajectoriam describen-  
dam. Tempus autem quo  
radius  $SZ$ , à centro ad cor-  
pus motum ductus, percurrent  
aream quamvis  $SPZ$ , erit  
ut differentia quadratorum  
ex  $SZ$  &  $SP$ : Nam area



percurfa, est ad illam differentiam, in data ratione Moduli dimidiati  
 $\frac{1}{2}SM$  ad  $SP$ . Velocitas vero corporis in loco quovis  $P$ , æqualis  
erit velocitati qua in Circulo, ad eandem distantiam  $SP$ , cum iisdem  
viribus revolvi posset. Ex constructione patet hanc secundam Spi-  
ralem esse Æquiangulam illam Propositionis sextæ; ea vero migra-  
bit in Circulum ubi angulus  $SPM$  fit rectus.

*Caf. 3.* Ut velocitas sit adhuc major, abeat jam punctum  $C$  ad  
distantiam plusquam infinitam à centro  $S$ , vel (quod perinde est)  
accedat à parte contraria eidem centro, ad finitam distantiam; &  
corporis de loco  $P$  secundum rectam  $PQ$  vel  $QP$  exeuntis, ea sit  
velocitas, quam acquirere posset ascendendo libere de loco  $C$  ad in-  
finitam distantiam, & deinde ab infinita distantia ex altera centri  
parte

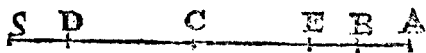






cota Mathesis vix quicquam in universo suo ambitu complectatur, præter angulorum & rationum Theoriam. Neque sane commodiora sperabit, qui animadverterit Effectiois facilitatem per amplissimas illas, omnibusque suis numeris absolutas, tum Logarithmorum tum Sinuum & Tangentium Tabulas, quas antecessorum nostrorum laudatissimæ solertiæ debemus acceptas. Ut vero tanti beneficii uberius nobis exsurgat fructus, id nunc exponendum restat, quibus artibus ad istiusmodi conclusiones rectissima perveniatur. In hunc finem Theoremata quædam, tum Logometrica tum Trigonometrica adiecissim, quæ parata ad usum asservo; ni consultius visum esset, quum absque nimis ambagibus ea tradi non possent, intacta potius præterire atque aliis denuo investiganda relinquere. Ceterum isthoc apparatu non semper est opus; nam in Methodo Fluxionum sæpe evenit ut ipsæ Fluentes, omissis huiusmodi subsidiis, ad Logometriam satis commode revocentur: id quod uno atque altero Exemplo ostendam.

Egimus in præcedentibus de rectilineo Gravium descensu, per Medii resistantiam continuam retardato, ex Hypothesi quod illa resistentia esset in duplicata ratione velocitatis. Ex eadem Hypothesi resistentiam corporis penduli, in Cycloide oscillantis, jam sit propositum invenire. Cycloidis itaque in rectam explicatæ sit  $AC$  dimidium,  $C$  punctum infimum,  $B$  punctum à quo cadere incipit corpus pendulum,  $BC$ ,  $CD$  arcus descensu ejus & subsequente ascensu descripti. Hisce positis, exquirenda est ratio quam habet resistentia corporis in loco quovis  $E$ , ad pondus ejus relativum in Medio resistente. Exponatur pondus illud per  $AC$ ; & vis ab eodem oriunda, qua pendulum acceleratur ad  $E$ , exponetur per  $CE$ : quæ si dicatur  $x$ , & momentum ejus  $\rightarrow \dot{x}$ ; momentum arcus jam descripti  $BE$  erit  $-\dot{x}$ . Exponatur vis resistentiæ per  $z$ ; & vis qua pendulum vere acceleratur, erit ut excessus vis prioris supra resistentiam, hoc est, ut  $x - z$ . Itaque cum resistentia sit ut quadratum velocitatis, resistentiæ momentum  $\dot{z}$  erit ut velocitas & velocitatis momentum, hoc est, ut  $-\dot{x}$  &  $x - z$ , sive ut  $z\dot{x} - x\dot{x}$ . Nam si tempus in particulas æquales dividatur, erit velocitas ut arcus descripti momentum  $-\dot{x}$ , & velocitatis momentum ut vis acceleratrix  $x - z$  quæ momentum illud generat. Quoniam ergo  $\dot{z}$  est ut  $z\dot{x} - x\dot{x}$ , si capiatur



piatur quantitas invariabilis  $a$ , quæ sit idoneæ magnitudinis: erit  
 $a\dot{z} = z\dot{x} - x\dot{z}$ .

Ad hanc æquationem construendam, assumatur quantitas  $v$  quæ sit variabilis, & fingatur æquatio  $z = p + qx + rv$ , in qua notæ  $p, q, r$  designent alias novas quantitates invariabiles; & erit  $\dot{z} = q\dot{x} + r\dot{v}$ . Hisce porro valoribus ipsarum  $z$  &  $\dot{z}$  substitutis in æquatione prima  $a\dot{z} = z\dot{x} - x\dot{z}$ , habebitur  $aq - p, \dot{x} + ar\dot{v} = q - 1, x\dot{x} + rv\dot{x}$ . Ut hæc æquatio simplicior evadat, ponatur  $q - 1 = 0$ , &  $aq - p = 0$ ; five  $q = 1$ , &  $p = a$ : & fiet  $a\frac{\dot{v}}{v} = \dot{x}$ , ac præterea  $z = a + x + rv$ . Jacentibus punctis  $D$  &  $S$  ad eandem partem puncti  $C$ , intelligatur  $CS$  æqualis ipsi  $a$ : & erit  $z = SE + rv$ , atque  $CS\frac{\dot{v}}{v} = \dot{x}$ . Sit

valor quantitatis  $v$ , dum incidit punctum  $E$  in punctum  $C$ : & quantitas  $x$ , five  $CE$ , æquabitur mensuræ rationis quam habet  $v$  ad  $c$  pro Modulo  $CS$ , per Propositionem primam: quam æqualitatem sic designare soleo,  $CE = CS \left| \frac{v}{c} \right.$ . Tota ergo Problematis difficultas jam

revocatur ad binas illas æquationes  $CE = CS \left| \frac{v}{c} \right.$ , atque  $z = SE + rv$ : hæc vero deduci non poterunt in usum, priusquam determinatæ fuerint quantitates  $r$  &  $CS$ . Ad hoc efficiendum, duæ restant conditiones nondum adimpletæ; oportet enim resistantiam esse nullam, atque adeo quantitatem  $z$  five  $SE + rv$  evanescere, ubi punctum  $E$  in puncta  $B$  &  $D$  incidit.

Sint ergo  $b$  &  $d$  valores ipsius  $v$ , dum incidit punctum  $E$  in puncta  $B$  &  $D$  respective: & in his casibus habebuntur  $SB + rb = 0$ ,  $SD + rd = 0$ . Unde  $r = -\frac{SB}{b}$ ,  $r = -\frac{SD}{d}$ , atque  $z = SE + rv = SE - \frac{v}{b} SB = SE - \frac{v}{d} SD$ . Porro erit  $\frac{SB}{SD} = \frac{b}{d}$ ; atque adeo  $CS \left| \frac{SB}{SD} \right. = (CS \left| \frac{b}{d} \right. = CS \left| \frac{b}{c} \right. - CS \left| \frac{d}{c} \right. = CB + CD) BD$ : unde dabitur punctum  $S$ .

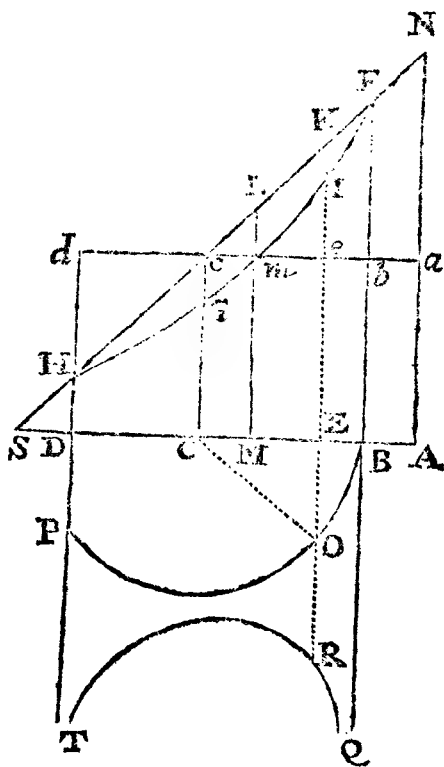
Componetur itaque Problema hunc in modum. Producat  $BD$  versus  $D$  ad  $S$ , eo usque, donec  $BD$  fuerit mensura rationis inter  $SB$  &  $SD$  ad Modulum  $CS$ . Deinde ad arbitrium posita quantitate  $c$ , ita capiantur quantitates  $b$  &  $v$ ; ut eodem Modulo  $CS$ , fiat  $CB$  mensura rationis quam habet  $b$  ad  $c$ , fiat quoque  $CE$  mensura rationis quam habet  $v$  ad  $c$ : & erit vis resistantiæ in loco  $E$ , ad pondus relativum corporis penduli, ut  $SE - \frac{v}{b} SB$ , ad  $CA$ .

Hujus

Hujus Problematis solutio utilitatem habet in Physica non contemnendam: quapropter constructionem ejusdem Linearem, ex eadem Analyfi deductam, subungere vilius est. Invento uti supra puncto  $S$ ; ad rectam  $SA$  erigantur perpendicularia  $DH$ ,  $Cc$ ,  $EK$ ,  $BF$ ,  $AN$ , rectæ  $SN$  utcumque per  $S$  ductæ occurrentia in  $H$ ,  $c$ ,  $K$ ,  $F$ ,  $N$ . Per punctum  $c$  ducatur recta  $da$  parallela rectæ  $DA$ , quæ iisdem perpendicularis occurrat in  $d$ ,  $c$ ,  $e$ ,  $b$ ,  $a$ ; & ad Asymptoton  $SA$  ducatur Logistica  $HGIF$ , quæ transeat per puncta  $H$  &  $F$ , fecerque perpendicularia  $Cc$ ,  $EK$  in  $G$  &  $I$ , ac parallelam  $da$  in  $m$ : namque his positis, erit pondus relativum corporis penduli, ad vim illam qua pendulum acceleratur ad punctum  $E$  in Medio non resistente, ut  $aN$  ad  $eK$ ; erit autem ad vim resistentiæ in loco  $E$ , ut  $aN$  ad  $KI$ ; atque adeo ad vim qua pendulum acceleratur ad punctum  $E$  in Medio resistente, ut  $aN$  ad  $eI$ . Porro, si per punctum  $m$  ducatur ad rectam  $SM A$  perpendicularis  $LmM$ , quæ fecerit  $SN$  in  $L$ : erit  $M$  locus ubi resistentia fit maxima: atque adeo resistentia illa maxima, erit ad pondus relativum penduli, ut  $Lm$  ad  $Na$ , hoc est, ut  $CM$  ad  $CA$ .

Ceterum si ita ducatur recta  $SN$ , ut abscindat rectam  $DH$  quæ sit dupla ipsius  $SD$ , centroque  $C$  & intervallo  $CB$  describatur Circulus  $BOP$ , qui occurrat perpendiculari  $KE$  in  $O$ : erit penduli in Medio resistente oscillantis velocitas in loco  $E$ , ad velocitatem penduli ejusdem ad eundem locum  $E$  delati per idem pondus relativum in Medio non resistente, ut media proportionalis inter  $CS$  &  $KI$ , ad  $EO$ .

Adhæc





Adhæc si jungatur  $CO$ , & in perpendicularo  $KE$  sumatur  $ER$ , quæ sit ad  $CB$  ut  $CB$  ad mediam proportionalem inter  $Ce$  &  $KI$ ; continuoque ductu rectæ  $ER$  in basim  $BE$  generetur area  $BQRE$ : erit tempus quo Cycloidis arcus  $BE$  describitur in Medio resistente, ad tempus quo idem arcus describeretur in Medio non resistente, ut area illa  $BQRE$ , ad Circuli sectorem  $BOC$ . Pergo nunc ad alia.

Densitatem Aeris invenimus ad quamvis altitudinem, ubi vis Gravitatis vel erat uniformis, vel decrefcebat in recessu à centro telluris in duplicata ratione distantiarum: libet eandem exquirere denovo, ubi gravitatio vel augetur vel diminuitur in ratione datæ cuiusvis dignitatis distantiarum. Sit  $S$  centrum telluris,  $A$  punctum in ejus superficie vel alibi utcumque situm,

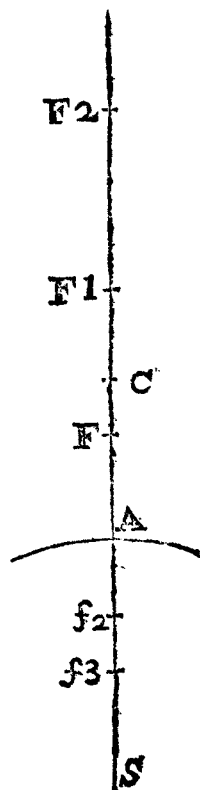
$SAF_2$  recta à centro ad summam Atmospheeræ producta: & quærenda sit ratio densitatis in loco  $A$ , ad densitatem in loco quovis  $F$ , ex Hypothesi quod vis gravitatis in  $F$  sit ut distantiarum  $SF$  dignitas quæcunque  $SF^n$ , cujus index est  $n$ . Pro  $SF$  scribatur  $x$ , ac designent  $d$  &  $v$  densitates Aeris ad  $A$  &  $F$ ; & cum densitas sit ubique ut pressura totius Aeris incumbentis, erit densitatis momentum ut momentum pressuræ, hoc est,  $\dot{v}$  ut  $v \dot{x} x^n$ , atque adeo  $\frac{\dot{v}}{v}$  ut  $\dot{x} x^n$ . Sit  $AC$  altitudo Atmosphæeræ,

cujus uniformis densitas eadem esset ac densitas loci  $A$ , vel sit  $AC$  ad altitudinem Hydrargyri barometrici in loco  $A$ , ut densitas Hydrargyri ad densitatem Aeris in eodem loco  $A$ : & si punctum  $F$  accedere intelligatur ad punctum  $A$ ; erit altitudo Hydrargyri barometrici in loco  $A$ , ad altitudinem Hydrargyri barometrici in loco  $F$ , ut  $AC$  ad  $FC$ . Aeris ergo in loco  $A$  densitas  $d$ , est ad Aeris in loco  $F$  densitatem  $v$ , ut  $AC$  ad  $FC$ : unde consequitur ut sit  $d = v$  five  $\dot{v}$ , ad  $d$  five  $v$ , ut  $AF$  five  $\dot{x}$ , ad  $AC$ .

Erit itaque, in hoc casu,  $AC \frac{\dot{v}}{v} = \dot{x} = \frac{x \dot{x}^n}{SA^n}$ .

Quoniam ergo, ubicunque sumeretur punctum

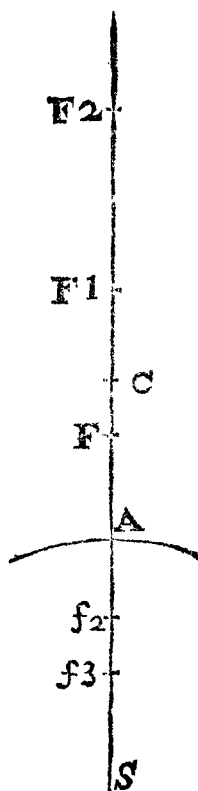
$F$ , erat  $\frac{\dot{v}}{v}$  ut  $\dot{x} x^n$ : erit porro  $AC \frac{\dot{v}}{v} = \frac{\dot{x} x^n}{SA^n}$ , ubicunque sumatur punctum  $F$ .



Jam si gravitatio sit reciproce ut distantia à centro, sive ut  $\frac{1}{x}$  vel  $x^{-1}$ ; erit  $n = -1$ , atque inde

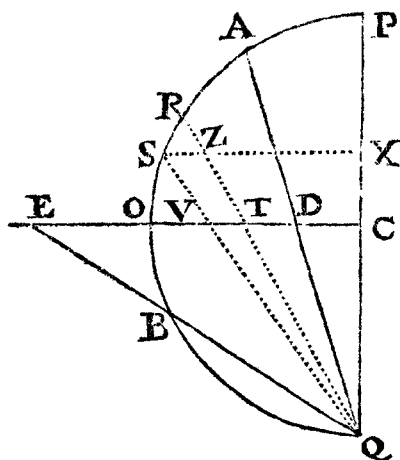
$AC \frac{\dot{v}}{v} = SA \frac{\dot{x}}{x}$ ; unde si Fluentes statuatur æquales, mensura rationis inter densitates  $d$  &  $v$  ad Modulum  $AC$ , æquabitur mensuræ rationis inter distantias  $SF$  &  $SA$  ad Modulum  $SA$ .

Si gravitationis sit alia quævis Lex: quoniam est  $AC \frac{\dot{v}}{v} = \frac{x \dot{x}^n}{SA^n}$ ; si Fluentes statuatur æquales, erit  $\frac{1}{n+1}$  in  $\frac{SF^{n+1}}{SA^n} - SA$  mensura rationis inter densitates  $d$  &  $v$  ad Modulum  $AC$ . Itaque si sumantur in progressionem Geometrica termini crescentes  $SA, SF, SF_1, SF_2$ , &c: decrecentes  $SF, SA, Sf_2, Sf_3$ , &c: mensura rationis inter densitates Aeris in  $A$  &  $F$  ad Modulum  $AC$ , erit  $\frac{1}{2} Af_3$ , si gravitatio sit reciproce in triplicata ratione distantia; erit  $Af_2$ , si gravitatio sit reciproce in duplicata ratione distantia; erit  $AF$ , si gravitatio uniformis statuatur; erit  $\frac{1}{2} AF_1$ , si gravitatio sit ut distantia; erit  $\frac{1}{3} AF_2$ , si gravitatio sit in duplicata ratione distantia. Et sic proceditur in infinitum.



Denique ut plenius constet, Syntheticas etiam demonstrationes ex elementis præmissis levi negotio concinnari posse; sufficiet unicum insuper addidisse Exemplum, tædet utique plura jam proferre. Repetatur itaque divisio illa Nautica Meridianæ quam supra attigimus, & videamus etiam absque ope Curvæ cujuspiam Logometricæ, annon simplicior aliquanto sit futura demonstratio ad modum sequentem. Sit  $PXCQ$  Telluris axis,  $CO$  semidiameter Æquatoris,  $PAOBQ$  Meridianus; & invenienda sit in planisphærio Nautico magnitudo cujusvis arcus  $AB$ . Ad arcus illius terminos  $A$  &  $B$  ducantur ab alterutro Polorum  $P$  vel  $Q$  rectæ  $QA, QB$ , semidiametro  $CO$  occurrentes in  $D$  &  $E$ : Dico magnitudinem Nauticam arcus  $AB$  æqualem esse mensuræ rationis inter  $EC$  &  $DC$  ad Modulum  $OC$ . Nam divisus intelligatur arcus  $AB$  in particulas

culas quam minimas  $RS$ , & jungantur  $QR$ ,  $QS$  quæ fecent  $CO$  in  $T$  &  $V$ ; & demisso in axem perpendiculo  $SX$  quod rectæ  $QR$  occurrat in  $Z$ , erit lineola  $SZ$  æqualis particulæ  $RS$ . Itaque magnitudo Nautica nascentis arcus  $RS$ , erit ad Sphæræ semidiametrum  $OC$ , ut arcus ille  $RS$  five lineola  $SZ$  ad  $SX$ , hoc est,



ut  $VT$  ad  $VC$ . Unde (per Corol. 2. Prop. 1.) magnitudo illa Nautica æquatur mensuræ rationis inter  $VC$  &  $TC$  ad Modulum  $OC$ : & similes utrobique summas colligendo, magnitudo Nautica totius arcus  $AB$  æquabitur mensuræ totius rationis inter  $EC$  &  $DC$  ad eundem Modulum  $OC$ .

III. *An Extract from the Acta Eruditorum for the Month of March, 1713. Pag. 111.*

**De Contagiosâ Epidemiâ, quæ in Patavino agro & totâ fere Venerâ ditione in Boves irrepsit, Dissertatio. Auctore Bernardino Ramazzini, Practicæ Medicinæ Professore Publico. Patavii, 1712. in 8vo.**

*A Dissertation concerning the dreadful Contagious Distemper, seizing the Black Cattle in the Venetian Territories, and especially about Padua.*

**I**T is now (at the Publishing the Discourse) a Year and half, since a dreadful, unexpected and violent Contagion has seiz'd the *Black Cattle*, which, like an increasing Fire, could neither be extinguish'd nor stop't by any Human means.

This first began to be observ'd a little in *Agro V'incentino*, and soon discover'd it self more openly in the Country, spreading it self every way even to the very Suburbs of *Padua*, with a cruel Destruction of the *Cows* and *Oxen*. It has also been taken notice of in *Germany*, in many Places; nor has it been yet wholly conquer'd, Publick News informing us, that it still remains in the Territories of *Milan*.

Of this so threaten'g a Distemper, the famous *Dr. Ramazzini*, according to his yearly Custom, on *November 9. 1711.* made a particular Dissertation; in which he inquir'd into the Causes of the Distemper, and shew'd what Remedies might be us'd, to put a stop to its violent Course.

It is sufficiently evident, that this Distemper, in the Cow-kind, was a true Fever, from the coldness, rigor and standing up of the Hair of the Cattle at first, which was soon succeeded by a violent sharp burning, with a quick Pulse. That this Fever was malignant, mortal and pestilential, its concomitant Symptoms plainly shew'd; such as great uneasiness with difficulty

ficulty of breathing, great pantings with a sort of snorting, and at the beginning a kind of *Stupor* and Drowziness, a continual Flux of a strong smelling Matter from the Nose and Mouth, a very fetid Dung, sometimes with Blood, all Rumination ceasing, Pustules breaking out over the whole Body on the 5th or 6th day, like the *Small Pox*; they all generally dy'd about the 5th or 7th day, very few of them escaping.

The Author deduces this Distemper from a contagious Original. He tells us, it is certain, that out of a great Drove, such as the Merchants bring yearly into *Italy* out of *Dalmatia* and the bordering Countries, one Beast happen'd to straggle from the rest, and be left behind; which a Cowherd finding, brought to a Farm belonging to the Illustrious and Reverend Count *Borromeo*, Canon of *Padua*: This Beast infected all the Cows and Oxen of the Place where he was taken in, with the same Distemper he labour'd under; the Beast it self dying in a few days, as did all the rest, except one only, who had a Rowel put into his Neck.

'Tis no strange thing therefore, if from the *Effluvia*, like an Atmosphere, proceeding from the sick Cattle, from those dead, and from the Cowhouses and Pastures where they were fed, and by that means infected, and chiefly from the Cloaths of the Cowherds themselves, this Infection falling upon a proper Subject, should diffuse it self so largely. When therefore this subtil venomous Exhalation happens to meet with any of the Cow kind, joining it self with the serous Juices and Animal Spirits, whilst it is carry'd all over the Body, disorders the natural consistence of the Blood, and corrupts the Ferments of the *Viscera*; whence it naturally follows, that the natural Functions of the *Viscera* are vitiated, and the requisite Secretions stop'd. For

Dr. *Ramazzini* not only supposes, but asserts, that this Poison is of that kind which rather fixes and coagulates, than dissolves the Blood: For besides the forementioned Symptoms accompanying the Disease, the Eye it self is a Witness; since the dead Carcasses being open'd while they are yet hot, little or no  
Blood

Blood nevertheless runs out; those Animals having naturally a thick Blood, especially when the Fever has continued so many Days. Whether therefore this Plague came first from the foreign Beast, or any other way, it is the same thing. when at last it fell upon some Animal in which there was the morbid Seminary or Ground prepared for it.

In the dead Bodies of all the Cattle it was particularly observed, that in the *Omasus*, or Paunch, there was found a hard compact Body, firmly adhering to the Coats of the Ventricle, of a large Bulk, and an intolerable Smell: In other Parts, as in the Brain, Lungs, &c. were several *Hydatides*, and large Bladders fill'd only with Wind, which being open'd gave a deadly Stink; there were also Ulcers at the Root of the Tongue, and Bladders fill'd with a *Serum* on the sides of it. This hard and compact Body, like Chalk, in the *Omasus*, the Author takes to be the first product of the contagious *Miasma*. He adds a Prognostick, believing that from so many Attempts and Experiments, and the Method observ'd in the Cure of this Venom, at last a true and Specifick Remedy will be found out to extirpate the poisonous Malignity wholly: He also expects some mitigation of it, from the approaching Winter and North Winds. He does not think this Contagion can affect Human Bodies, since even other *Species* of ruminating Animals, symbolizing with the Cow-kind, are yet untouch'd by it; nor was the Infection catch'd from the Air, provided due care was taken in the burying the dead Bodies.

As for the Cure of it: From the *Chirurgical* Part he commends Bleeding, burning on both sides the Neck with a broad red-hot Iron, making Holes in the Ears with a round Iron, and putting the Root of *Hellebore* in the Hole, a Rowel or Seton under the Chin, in the Dew-laps; he also orders the Tongue and Palate to be often wash'd and rub'd with Vinegar and Salt.

As for the *Pharmacutical* Part: he recommends *Alexipharmicks*, and specifick Cordials; and from the *Veg table Kingdom*, three Ounces of *Jesuits Bark*, infus'd in 10 or 12 Pints of Cordial Water or small Wine, to be given in 4 or 5 Doses; which  
is

is to be done in the beginning of the Fever, when the Beast begins to be sick. From the *Animal*, two Drams of *Sperma Cati* dissolv'd in warm Wine. From the *Mineral*, *Antimonium Diaphoreticum*. Against *Worms* breeding, an Infusion of *Quicksilver*, or *Petroleum* and Milk is to be given. And lastly, as to the *Food*, Drinks made with Barly or Wheat Flower or Bread, like a *Ptisane*, fresh sweet Hay made in *May* and macerated in fair Water. In the mean time the Cattle must be kept in a warm Place, and cloath'd, to keep them as much as possible from the cold Air, daily making Fumigations in the Cowhouses with *Juniper Berries*, *Galbanum*, and the like. As to Prevention; he enjoyns Care in cleaning the Stalls, and scraping the Crust off from the Walls; Care also is to be taken of their Food, that it be good, the Hay and Straw not spoil'd by Rain in the making, and judges their Food ought to be but sparing; Friction, rubbing and currying, not only with the Hand, but with a Currycomb and Brush; with Scrons under their Chin, made with a hot Iron run through the Part, and kept open with a Rope put through it.

---

---

IV. *A Recipe: Or the Ingredients of a Medicine for the spreading mortal Distemper amongst Cows: Lately sent over from Holland, where a like Distemper raged amongst the Black Cattle.*

**R** *Ecipe Veronica, Pulmonaria, Hyssopi, Scordii, ana M. iv Rad. Aristolochia rotunda, Gentiana, Angelica, Petasitis, Tormentilla, Carlina, ana unc. 12. Bac. Lauri & Juniper ana unc. 12. Misc. fiat Pulvis.*

Bleed the Cow, and give her every Morning, for 3 or 4 Mornings, an Ounce of this Powder with a Horn in warm Beer.

If the Cow's Illness continues, after the omission of 2 or 3 Days, repeat the Medicine for 3 or 4 Days again.

*F I N I S.*

---

ERRATA. Pag. 43. Lin. 2. for *Cc*, read *4CS.*

---

L O N D O N, Printed for WILLIAM INNYS, at the Prince's-Arms in St. Paul's Church-yard. 1714.



# PHILOSOPHICAL TRANSACTIONS.

---

For the Months of *April, May and June, 1714.*

---

## The C O N T E N T S.

- I. **A** *New Method for making Logarithms, and vice versâ, for finding the Number corresponding to a Logarithm given, by help of a small Table. Communicated by Mr. John Long, S. Theol. Bacc. and Fellow of Corp. Christi Coll. Oxon.*
- II. *An Extract of a Letter from Mr. Anthony van Leewenhoek, F. R. S. containing his Observations on the small Fibres of the Muscles in several Animals.*
- III. *An Extract from the Journal Litteraire, &c. giving an Account of several Observations of the Texture of the Muscles, by Mr. Muys, Professor of Anatomy at Franequer.*
- IV. *An Extract of several Letters from Cotton Mather, D. D. F. R. S. to John Woodward, M. D. S. R. S. & Prof. Med. Gresh. and to Ric. Waller, Esq; S. R. Secr.*
- V. *A Letter from Emanuel Timone, Philos. & Med. D. in Univerf. Oxon. & Patav. S. R. S. containing the Method of Inoculating the Small-Pox; practis'd with Success at Constantinople, &c.*
- VI. *Theoremata quædam infinitam Materiæ divisibilitatem spectantia, &c. A Johanne Keill, M. D. Astron. Profef. Savil. Oxon. & S R. S.*

---

E R R A T A, in the *Philos. Transf.* Numb. 337.

**P**A G. 80. lin. 3. lege *Societatis à secretis*. P. 88. l. 6. l. *rotundo*. P. 158. l. 25. l. *suspicio, agnoscam*. P. 159. l. 9. l. *præflari*. P. 285. l. 25. l. *Legions* P. 288. l. 1. instead of *NN* there should be a Ligature *N*, with the last Line raised a little higher than the first.

I. *A new Method for making Logarithms, and vice versâ, for finding the Number corresponding to a Logarithm given, by help of the following Table. Communicated by Mr. John Long, S. Theol. Bacc. and Fellow of Corpus Christi Coll. Oxon.*

Log.	Nat. Num.
0,9	7.943282347
0,8	6.309573445
0,7	5.011872336
0,6	3.981071706
0,5	3.162277660
0,4	2.511886432
0,3	1.995262315
0,2	1.584893193
0,1	1.258925412
0,09	1.230268771
0,08	1.202264435
0,07	1.174897555
0,06	1.148153621
0,05	1.322018454
0,04	1.096478196
0,03	1.071519305
0,02	1.047128548
0,01	1.023292992
0,009	1.020939484
0,008	1.018591388
0,007	1.016248694
0,006	1.013911386
0,005	1.011579454
0,004	1.009252886
0,003	1.006931669
0,002	1.004615794
0,001	1.002305238

Log.	Nat. Num.
0,0009	1.002074475
0,0008	1.001843766
0,0007	1.001613109
0,0006	1.001382506
0,0005	1.001151956
0,0004	1.000921459
0,0003	1.000691015
0,0002	1.000460623
0,0001	1.000230285
0,00009	1.000207254
0,00008	1.000184224
0,00007	1.000161194
0,00006	1.000138165
0,00005	1.000115136
0,00004	1.000092106
0,00003	1.000069080
0,00002	1.000046053
0,00001	1.000023026
0,000009	1.000020724
0,000008	1.000018421
0,000007	1.000016118
0,000006	1.000013816
0,000005	1.000011513
0,000004	1.000009210
0,000003	1.000006908
0,000002	1.000004605
0,000001	1.000002302

<i>Log.</i>	<i>Nat. Num.</i>	<i>Log.</i>	<i>Nat. Num.</i>
0,0000009	1.000002072	0,0000009	1.000000207
0,0000008	1.000001842	0,0000008	1.000000184
0,0000007	1.000001611	0,0000007	1.000000161
0,0000006	1.000001381	0,0000006	1.000000138
0,0000005	1.000001151	0,0000005	1.000000115
0,0000004	1.000000921	0,0000004	1.000000092
0,0000003	1.000000690	0,0000003	1.000000069
0,0000002	1.000000460	0,0000002	1.000000046
0,0000001	1.000000230	0.00000001	1.000000023

This Table is what I sometimes make use of for finding the Logarithm of any Number propos'd, and *vice versâ*. For instance: Suppose I had occasion to find the Logarithm of 2000. I look in the first Class of my Table (the whole Table consists of 8 Classes) for the next less to 2, which is 1.995262315, and against it is 3, which consequently is the first Figure of the Logarithm sought. Again; dividing the Number propos'd 2, by 1.995262315 the Number found in the Table, the Quotient is 1.002374467; which being look'd for in the second Class of the Table, and finding neither its equal, nor a lesser, I add 0 to the part of the Logarithm before found, and look for the said Quotient 1.002374467 in the third Class, where the next less is 1.002305238, and against it is 1, to be added to the part of the Logarithm already found; and dividing the Quotient 1.002374467, by 1.002305238, last found in the Table, the Quotient is 1.000069070; which being sought in the fourth Class gives 0, but being sought in the fifth Class gives 2, to be added to the part of the Logarithm already found; and dividing the last Quotient by the Number last found in the Table, *viz.* 1.000046053, the Quotient is 1.000023015, which being sought in the sixth Class, gives 9 to the part of the Logarithm already found: And dividing the last Quotient by the new Divisor, *viz.* 1.000002072, the Quotient is 1.000000219, which being greater than 1.000000115, shews that the Logarithm already found, *viz.* 3.3010299 is less than the Truth by more

more than half an Unit; wherefore adding 1, you have *Briggs's* Logarithm of 2000, viz. 3.3010300.

If any Logarithm be given, suppose 3.3010300, throw away the Characteristic, then over against these Figures 3... 0... 1... 0... 3... 0... 0, you have in their respective Classes 1.995262315... 0... 1.002305238... 0... 1.000069080... 0... 0 which multiplied continually into one another, the Product is 2.000000019966, which by reason the Characteristic is 3, becomes 2000.000019966, &c. that is, 2000, the Natural Number desired. I shall not mention the Method by which this Table is fram'd, because you will easily see that from the use of it.

It is obvious to the intelligent Reader, that these Classes of Numbers are no other than so many Scales of mean Proportionals: In the first Class, between 1 and 10; so that the last Number thereof, viz. 1,258925412 is the tenth Root of 10, and the rest in order ascending are the Powers thereof. So in the second Class, the last Number 1,023292992 is the hundredth Root of 10, and the rest in the same manner are Powers thereof. So 1,002305238 in the third Class, is the tenth Root of the last of the second, and the rest its Powers, &c. Or, which is all one, each Number in the preceding Class, is the tenth Power of the corresponding Number in the next following Class: Whence 'tis plain, that to construct these Tables requires no more than one Extraction of the fifth or sursolid Root for each Class, the rest of the Work being done by the common Rules of Arithmetick; and for extracting the fifth Root, you will find more than one very compendious Rule in *Num.* 210 of these *Transactions*, if any one shall desire to examin the *computus* of these Tables.

The Process is exactly the Reverse of Mr. *Briggs's* Doctrine, in *Cap.* XII. of his *Arithmetica Logarithmica* of *Flacq's* Edition; and had *Briggs* been appriz'd hereof, it would have greatly eased the Labour of deducing the Logarithms of the first prime Numbers, which appear to have cost him so much Pains.

III. *An Extract of a Letter from Mr. Anthony van Leeuwenhoeck, F.R.S. Dated October the 12th. 1713. Concerning the Fibres of the Muscles, &c.*

GENTLEMEN,

**I**N compliance with your desires, I here send you a Copy of the Observations I communicated to the great Pensionary *Monsieur Heinsius*, concerning the Membranes with which the *Fibrillæ* of the Muscles appear to be encompassed, both in the Flesh of a Whale, Cod-fish, Salmon, and Smelt; and also in that from an Oxe to a Mouse; in all which the appearance was the same.

The Flesh of the Whale, was a small piece cut off near the Tail of the Fish, which I desired a Sea-Captain to bring me, that I might observe how the Flesh in that part was joined to the Tendons in so large an Animal. Viewing this thro' the Microscope, I judged the Fibres thereof to be four times as large as those I had formerly observed in another piece of Whale's Flesh, taken from another part of the Fish; which made me consider, whether the Fibres of that part might not be, by Nature, furnished with larger Fibres for its greater strength.

Cutting the said Flesh-parts length-wise, and across the Fibres, I discovered more plainly than before, that each Particle or Flesh-fibre, was enwrapt in a fine thin Membrane.

To have a better Idea of these Flesh-fibres of a Whale, I cut a thin slice of it across, which I laid on a wetted piece of Glass, that the Flesh which was very dry and shrunk, might, by the moisture be swelled, and thereby distended to the natural size it had when on the Body of the Fish itself. In this state, placed before the Microscope, it appeared as I caused it to be drawn in the Figure. *A B. C. D.* in which the Parts were so close together, that their encompassing Membranes, represented by the black Lines, were but just discernable, some whereof appeared larger than others: these, if attentively viewed, seem'd  
plainly

plainly to be divided into multitudes of others, cut also transverse, the bigness of which was no larger than a common Sand to the naked Eye. These were so close crowded together, that their Figure was very irregular, as well as their sizes different; for tho' each seem'd encompassed with six others, yet some of them were twice as large as the other.

Having formerly mentioned the slenderness of these *Fibrille* in the Flesh of a Whale, and judging these, as I said before, to be four times as large, I took a thin slice of the formerly mentioned Whale-flesh (which I had still kept by me) and after having made it thoroughly wet, I viewed it with the same Microscope as I had done this of the Tail. This appear'd as is represented (*Fig. 2.*) *E. F. G. H.* Letting the moisture dry away from these slices, so stuck on to the Glass, the Particles became much smaller, and the Membranes with which each was encompassed, became very visible; that is, those which were not shrunk away; which was a very entertaining Object to the curious; and as often as I made new Cuts, a new Object presented it self.

A small Particle of this Flesh I caused to be drawn, as in (*Fig. 3.*) *I K L M.* These Particles seem'd to touch and be joined to others; but now being dried, they shrunk in from the Membranes round about them; for the Membranes could not shrink, because they were all joined to one another.

Along these Flesh-fibres there runs some such thick Membranes, that they equal the thickness of a Hair or more, which are scarce distant the breadth of a Sand from each other; from these larger Membranes other parts are spread, dividing each Fibre into numerous *Fibrilla*; so that it may be said, each flesh Fibre, no bigger than a Hair, is a little Muscle encompassed in its peculiar Coat or Membrane, as I have said before. Whereas the Designer had not the same apprehension of the size of these Fibres, as I and some other Persons had, I made him draw a little piece as large as it appeared to my apprehension, as in (*Fig. 4.*) *N. O. P.* whence appears the difference of one Man's sight from another.

I have also often seen some few of these Fibres, tho' joyned to others, yet but one Fourth of their bigness to which they were joined.

When I again moistend those represented in the Third and Fourth Figures, (dryd up and shrunk) they would be again so swelled and distended, as to fill up the spaces between the Membranes, and re-assume the Shape they had before they were dried. Among several little pieces of Flesh placed before another Microscope, and moisten'd as before, there was one, whose Particles were not separated upon drying, which I supposed to be, from the splitting and tearing asunder of a large Membrane that run thro' the middle of it, as may be seen in (*Fig. 5.*) *Q. R. S. T. V. W.* where between *S. T.* and *V.* the dried Particles remain unseparated; these being cut a little thicker appeared also of a darker hew, and if they had been sliced yet thicker would have appeared of a dark red. By *S. W.* is represented the thick Membrane dividing this piece, which was about the bigness of a Hair; this at *T.* sent out a Branch, and near *W.* is split into two, I apprehend that a great number of Blood-vessels are spread over this Membrane, which by their smallness are not visible; for it is by these the Nourishment is convey'd. Between *R. S.* and *Q. W.* the exceeding fine Membranes torn from the great are visible.

Is it not amazing that in such vast Animals as a Whale, such exceeding small *Fibrille* should be found? nay, such they are in small Animals; and that the whole fifth Figure is not so large as a coarse grain of Sand.

This Whale was so large, that the upper part of its Body yielded 60 Quarteels of blubber or Fat, which allowing 30 *Rotterdam* Stopes (making each about 3 English Quarts) to one Quarteel, it will nearly amount to 24000 Pound weight; besides, there is a very great deal of Fat about the Entrails.

Then I caused a very little piece, consisting only of five *Fibrille*, to be drawn lengthwise, as they were seen thro' the Microscope, as (in *Fig. 6.*) *A. B. C. C. E. F.* in which Figure at *A.* and a little at that place, it is divided into two *Fibrille*. Between *C.*

and *F.* are to be seen the little Membranes which encompass the *Fibrillæ*, which are here torn asunder.

I have frequently, with pleasure, observed these Flesh-fibres lengthways, to be as it were corrugated or wrinkled, which I imagined to be the Representation of their Rest or unbent Posture; and yet more, when the Part to which they belong is bowed together, or brought nearer; but when the Muscle is extended, and its Antagonist acts, there is not the least wrinkle observable in these *Fibrillæ*.

However, all the little Inequalities in these *Fibrillæ* must not be taken for those Corrugations, since many of them are only the Articles torn off from the Membranes which encompass the *Fibrillæ*.

Figure (7) *G. H. I. K.* represents four little Fibres of a piece of Whales-Flesh I had procured two Years since; this I caused to be drawn to shew the difference. By the two Figures 6 and 7, is visible the Diameters of the Fibres are as big again in one, as in the other, therefore the Fibres must be four times as big in *Fig. 6.* as in *Fig. 7.* Now each Flesh-fibre being composed of a great many smaller *Fibrillæ*, we may imagine each of these in-lying Fibres do likewise consist of others of the like Nature.

I have a fresh viewed several small Fibres of Ox-Flesh, and observed, that each of the *Fibrillæ* in them was encompassed with a thin Membrane. But I cannot shew these Membranes so clearly to other Persons in Cows-Flesh, as in Whales-Flesh; because the Parts of the former are of a much more compact and close Texture than that of the Whale, from whence they do not shrink so much in drying.

I am of Opinion, that what I have said of the Membranes (encompassing the Fibres and *Fibrillæ*) of the Flesh in a Whale, will likewise hold true in other kinds of Flesh; yea even down to that of a Rat or a Mouse: Concerning which I shall prosecute my Observations. I conclude, &c.



To these Observations of Mr. *Leewenhoek* I shall join,

III. *An Extract from the Journal Litteraire, Publish'd at the Hague, for the Months of January and February, 1714. Pag. 238. Being.*

*An Account of several Observations concerning the Frame and Texture of the Muscles; By Mr. Muys of Franequer:*

THE Celebrated Mr. *Muys*, who always acts for the Honour of the Academy of *Franequer*, and Advantage of Students in Physick and Anatomy, has made several Discoveries, as to the Mechanism and Texture of the Muscles of Animals; of which these are some.

He has observed, that the fleshy Fibres of the Muscles are composed of other smaller Fibres, which he calls *Fibrillæ*: that these *Fibrillæ* are of the size of a slender Hair, and that 500 or 600 of them, may be counted in one Fleshy-fibre, whose Diameter is no more than a 24th part of an Inch.

That each of these *Fibrillæ* also is made up of more than 300 little transparent *Tabuli*, but so slender, that if a Blood Globule (which, according to Mr. *Leuwenhoek*, is but the 1,000,000th part of a grain of Sand) were divided into 24 parts, one of these could hardly pass thro' these small Pipes.

He has shewn, that tho' the fleshy-Fibres of the Muscles, are joined to the Tendons and tendinous Membrane of a Muscle; yet these tendinous Fibres are not a continuation of the fleshy ones, as most Anatomists suppose: which he proves thus; If by means of a wooden Knife, or only by pulling it, you separate the fleshy Fibres from the Tendon, the end of the Tendon to which they were joined, will remain smooth and even, and not rugged.

Having

Having made several Injections of warm Water into the crural Artery of a Lamb of a Year old, all the fleshy-Fibres lost all their redness, and became entirely white. The Fibres being whitened by this Injection, he injected a coloured Liquor by the same Artery; and then not only the small Arteries appeared filled with this tinged Liquor, but he found also that the Liquor pass thro' each Fibre, either in a Serpentine manner, or undulating, or framing several Angles, or joined by a great number of *Anastomoses*.

He observed also, that many small Branches of the Arteries which before could not be seen, appeared visibly, spread all round the little *Fibrillæ*, and tinged with the same Colour.

Having remarked, that the Parts of the fleshy Fibres, which were near the Extremities of the Arteries, appeared tinged with the Liquor, he examined them with a Microscope, and found the little *Fibrillæ* filled and tinged with the same Liquor; and yet there was not least appearance of the Liquor in the *Interstices* between the *Fibrillæ*.

Having made Injections by the crural Artery, of another coloured Liquor, in the Muscles, whiten'd, as before, with Water, he saw not only the Fibres in some of the Muscles, and the most part of them in the others filled with this matter; but having examined them with a good Microscope, he found the *Fibrillæ*, and even the least *Tubuli* which compose them, filled and tinged with the same Matter; and nevertheless the small Ramifications of the Nerves appeared perfectly white.

It results from all these Observations,

1st. That the little Tubes, which make a *Fibrilla*, are really hollow, and that the Extremities of the Capillary Arteries open into them, and empty there a part of their Liquor, which is re-conveyed by the Veins to the Heart.

2d. That the Blood Globules must be divided into an almost infinite degree of smallness, before they can enter and pass these *Tubuli*. That the Blood-Globules may be so divided, and when so divided pass thro' the small *Tubuli*, is evident from

from the redness of the Fibres and *Fibrille* of Animals, which have a red Flesh; which will be no surprize to them who have read Mr. *Leeuwenhoek's* Letter 42, where he says, that these Globules do divide themselves after this manner, to pass thro' the last Extremities of the Capillary Arteries of the Brain; nor to those who know, that the Globules are extreame soft and easily separable, as *Monsieur Muys* has evinced by Arguments grounded on very curious Observations.

*Monsieur Muys* has added to his Observations very exact Figures, which contribute very much to the forming a clear and distinct Idea of the Structure of these Fibres of the Muscles, and of the manner of the Arteries passing through them; but I dare not so far depend on my Skill in designing to venture to Copy them.

This knowing Person has also made several Discoveries of the Course and Ramifications of the Nerves in the Muscles: But I wait for an Opportunity of informing myself better of several Particularities, before I communicate them to you.

In my last I wrote to you concerning the Salts which Mr. *Muys* had discover'd in Human Blood; but I had forgot to inform you, that he had found out a way to separate them from the Blood, without any Chymical *Analysis*, and without making them undergo any change, and to form them into *Cristais*, visible without a Microscope; as he has shewn to his Students in Physick.

IV. *An Extract of several Letters from Cotton Mather, D.D. to John Woodward, M.D. and Richard Waller, Esq; S. R. Secr.*

THE first Letter directed to Dr. *Woodward*, is dated at *Boston* in *New England*, Nov. 17. 1712. In this the Writer gives an Account of a large Work in Manuscript, in two Volumes in Folio, but does not name the Author. This, according to the account of it, is a large Commentary upon some Passages in the Bible, interspers'd with large Philosophical Remarks, taken out of Natural Historians, and the Observations of himself and others, more particularly as to Matters observ'd in *America*, whence he entitles the Work, *Biblia Americana*. This Work Dr. *Mather* recommends to the Patronage of some generous *Mecenas*, to promote the Publication of. As a Specimen of it, he transcribes a Passage out of it, being a Note on that Passage in *Gen Chap. 6. v. 4.* relating to *Giants*; and confirms the Opinion of there having been, in the *Antediluvian* World, Men of very large and prodigious Statures, by the Bones and Teeth of some large Animals, found lately in *Albany* in *New England*, which, for some Reasons, he judges to be Human; particularly a *Tooth* brought from the Place where it was found to *New York*, 1705. being a very large Grinder, weighing 4 pounds and three quarters, with a Bone, suppos'd to be a *Thigh-bone*, 17 Foot long. He also mentions another *Tooth*, broad and flat like a fore-Tooth, four Fingers broad: the Bones crumble to pieces in the Air after they are dug up; they were found near a place call'd *Cluverack*, about 30 Miles on this side *Albany*. He then gives the Description of one, which he resembles to the *Eye-Tooth* of a Man; he says it has four Prongs, or Roots, flat, and something worn on the top;

top it was six Inches high, lacking one eighth, as it stood upright on its Root, and almost thirteen Inches in circumference; it weigh'd two pounds four ounces *Troy* weight. There was another near a pound heavier, found under the Bank of *Hudson's River*, about fifty Leagues from the Sea, a great way below the Surface of the Earth, where the Ground is of a different Colour and Substance from the other Ground, for seventy five Foot long, which they suppose to be from the rotting of the Body, to which these Bones and Teeth did, as he supposes, once belong. *It were to be wish'd the Writer had given an exact Figure of the Teeth and Bones.*

The second Letter to the same Person, is dated Nov. 18. 1712. from *Boston*, as all the following are. In this he treats of the Plants of *America*; and, in the first place, offers a Conjecture of his concerning the *Shittim* Wood, mentioned in the Sacred Writings to be made use of for the Ark, &c. It is said to be not as most other Woods, subject to rot: He judges that it was the black *Acacia*; that the *Gopher* Wood was the *Juniperus arbor tetragonophyllos*, frequent in the *East-Indies*, &c. He observes that the *Indians* often perform very great Cures with their Plants; of which there is a great variety, differing from the *European*, which he promises a Catalogue and Description of; and, for the present, instances in some. As, a Plant efficacious in curing *Inflammations*, whence they call it *Antierisypelas*; it grows plentifully in the Woods: A Chymical Oil extracted from it, taken inwardly, does Wonders in absorbing scorbutick Salts. Another Plant, which goes by the Name of *Partridge-berries*, excellent in curing the *Dropsy*; a Decoction of the Leaves being drank several days as a Tea, discharging a vast quantity of Urine, as long as the Disease lasts; after which it may be drank without provoking Urine observably: Gouty Persons drink it with benefit.

The Root call'd the *Bleeding Root*, curing the *Faun-*  
*dies* in five or six days.

Another for *Gangrenes*, of which he does not give the Name.

Another Specifick for the Bite of the *Rattle-Snake*, and another for *Quinsies*, or sore Throats. A Plant, call'd by the *Indians*, *Taututtipang*; infallible for the *Lues Venerea*, the Root being used in a Decoction, and drank half a Pint; a Cataplasim of the same Root, bruised, apply'd to the Ulcers, cures them also.

A Thistle call'd the *Boar-Thistle*; very short and prickly, with a large and long Root. To this they add a Root, call'd the *Cancer Root*, and a sort of *Devils Bit*: A Decoction of which three Roots is a Cure for the *King's-Evil*, tho' very far gone; a small quantity being drank every day, and the bruised Roots apply'd to the Scrophulous Tumors.

But of these *American* Plants he promises a larger Crop.

The third Letter relates chiefly to the Birds of that Country; where, he says, they have many of the same *Species* with ours in *England*. He mentions very large wild *Turkies*, some weighing 50 or 60 pound, but the Flesh is very tough and hard. He takes notice of a very large *Eagle* with a great Head, soaring very high, as all of that *Genus* do. As to the Itinerants; he takes notice of vast Flights of *Pigeons*, coming and departing at certain Seasons: And as to this, he has a particular Fancy of their repairing to some undiscovered Satellite, accompanying the Earth at a near distance.

The next Letter relates to *Antipathies*, and the Force of the *Imagination*. As to the first, he says, a Gentlewoman of his Neighbourhood swoons upon the seeing any one cut their Nails with a Knife; which if done with a Pair of Scissors has no Effect upon her. The Wife of a Person, vomiting

miting upon seeing her Husband take a Vomit; the Patient that took it being not mov'd, but forc'd to take a fresh Emetic.

Some Histories are here related of the *Macula Materna*. One particularly, of a Woman longing for Peas, but refusing to gratifie her desire, for fear of a sort of Bug, with which at that time most of their Peas were infested; this Woman's Child, when born, had an Excrecence on the Forehead, resembling one of those Peas, with a black Speck, as the buggy Peas had, which after some time, dry'd away, and shell'd out they fancy'd, as the Bugs are observ'd to leave the Husk of the Pea.

This Letter concludes with an account of a Stone, generated under the Tongue, near the Root.

The fifth Letter gives an account of some *monstrous Births*, but nothing very observable.

The sixth Letter relates the Stories of some Persons that had Informations of Medicines for the Distempers they lay under, in their Dreams; these Accounts relate little to Natural Philosophy.

The next, and last to Dr. *Woodward*, relates the Cures of several Wounds in Persons, which were judg'd mortal. In this little of Philosophical Information.

The next Letter, being the first to Mr. *Waller*, is dated at *Boston*, Nov. 24. 1712. In this the Writer observes, in the first place, That the *Indians* have no Division of Time, except by *Sleeps*, *Moons* and *Winters*. Altho' the *Indians* have not divided or distinguished the Stars into Constellations, yet it is observable that they call the Stars of *Ursa Major*, *Paukumaw*, that is, *the Bear*; and this long before they had any Communication with *Europeans*. He says,

there is a Tradition among them, that in *November*, 1668. a Star appear'd below the Body of the Moon, within the Horns of it. In the next place he mentions the *Evening Glade*; first taken notice of by Dr. *Childrey*, to be constantly observ'd there in *February*, and a little before and after that Month; adding, that the Cause of that Appearance must be sought for above the Atmosphere. Then he gives a new Method of his own for finding the *Julian Period*, adding a Table for that purpose; which concludes this Letter.

The next relates the Appearances of several uncommon *Rainbows* and *Mock Suns*. On the 2d of *January*, in a clear Sky, but very cold; the Sun was from Ten o' Clock, for near Three Hours after, attended with four *Parhelia*, in the midst whereof were two Rainbows.

About six Weeks after this, in a Day much colder than used to be at that time of the Year, the Air a little hazy, a little after One o' Clock, for about half an hour, four Mock-Suns were seen.

He observes, that these Appearances with them are of great varieties, each usually differing in some respect from the other.

The next Letter dated, *Nov. 26th.* to the same Person, has the Relation of a strange Discovery of the Murder of a Person in *England*, to his Brother *Joseph Beacon*, at that time at *Boston*, in a Dream; the Person wounded appearing with the Wound on his Head; with the Attestations of several Persons, as to the Truth of it. The Information by the Dream was on the 2d of *May*, 1687, about Five o' Clock in the Morning; on the very same Day his Brother dy'd at *London*, of the Wounds he had receiv'd in *April* before: Of which Misfortune his Brother *Joseph Beacon* neither had, nor could have any notice, till the next Communication by Shipping, towards the latter end of *June* following; when he had a Letter of his Brother's Death, and the Cause of it,



it, agreeable to his Dream, but this not directly relating to Natural Philosophy, I omit the Particulars, tho' the Relation seems to be well attested.

The following Letter sent likewise to Mr. Waller, treats chiefly of the *Rattle-Snake*, hinting at the occasion of its Name, from the Rattles in its Tail, in which he says are sometimes twenty of those loose Rings, tho' he does not come in with the Opinion, that one is added every Year. Next follow these Observations. That the more Northerly they travel, these Snakes are less numerous, as well as less venomous; nor as it is said, are any seen to the North of *Merimack River*, which is about 40 miles North of *Boston*. Here he relates a Story, as he says, constantly affirmed by the *Indians*, that these Snakes frequently lie coiled at the Bottom of a great Tree, with their Eyes fixed on some Squirrel above in the Tree; which tho' seeming by his cries and leaping about, to be in a Fright, yet at last runs down the Tree, and into the Jaws of the Devourer. Then he relates, that the Winter abroad of these Snakes is in the Clefts of inaccessible Rocks, from whence in the Spring, they come forth a Sunning themselves, at first very feeble, which is their chief time of destroying them. At this time the *Cystis* or Gall bladder in these Snakes is full of an acid azure coloured Juice, which they squeeze out into a Glass, but it is so Spirituous, that if the Glass be not immediately stoppt, it will soon evaporate; this Liquor therefore they mix with a convenient quantity of powder'd Chalk or *Indian Meal*; and use it as a proper Medicine against the venomous Bite of this Snake; some have named it *Trochisci Connecticutiani*, from the *Connecticut Colony*. 'Tis observable when the Summer Hears come on, the Snakes have no longer this azure Liquor in their Gall-Bladders, in which there is only found a black thick Sediment, of no known use, at which time they think the forementioned spirituous Juice is carried to, and lodged in their Gums, and so conveyed or thrown by the hollow of the Teeth into the Wound, when they Bite, having received another Digestion,

sion, and higher Exaltation, by passing thro' several Strainers and Glands before it arrives to the Gums; as an instance of the virulence of this Liquor, he tells us, that a Traveller killing one of these Snakes, suffered the enraged dying Viper, to bite the end of his Switch, with the lashes of which he had disabled him; and a Fly by chance disturbing one of his Temples as he rode on afterwards, he rub'd his Temple with the other end of the Switch, which as he relates it, immediately caused his whole Head to swell to a great excess, the Poison as he supposes permeating the whole length of the Switch. He adds another relation as to the penetrating quality of this Poison, a Person provoking a *Rattle-Snake* to bite the Edge of a broad Axe he had in his Hand; the colour, of the Steeled part bitten, was immediately changed, and at the first stroke he made with it in using his Ax, the so discoloured part broke out, leaving a gap in his Ax. But to return to the *Trochies* made of the Gall, he says it is a Cordial sudorifick, and so good an Anodine, that he knows some who take 3 or 4 Grains of it to compose them to rest after Travel. 'Tis good in all Fevers, especially the Malignant. 'Tis an infallible Remedy for Obstructions incident to Women upon catching cold in Childbed. Being taken in a convenient Quantity, 12 Hours before the Fit, it certainly cures a Quartan Ague. The Dose is 14 Grains more or less according to the Circumstances of the Patient in any Vehicle. The next Letter treats of the Effects of *Thunder* and *Lightning* very frequent with them, which from its frequent destroying Animals, without any visible Hurt on the external Parts, he compares to the *Jewish* Punishment of pouring melted Lead down the Throats of the Condemn'd which they call'd *combustio animæ*. Tho' he likewise observes some have had their Hair singed with Marks on their Skin like those made by small Shot; some have had their Bones made limber like a Gristle. The Captain of their Castle was found Dead in his Bed after a storm of *Lightning* without any apparent Hurt. Here he relates a Passage of which an Account has sometime since

since been given in the *Philosoph. Transact.* but is here confirm'd That July 24th, 1681. A Ship whereof one Mr. *Lad* was Master about 100 Leagues from *New England* in Lat. 38. met with a violent storm of *Thunder*, which did much Damage to the Ship; at which time, a bituminous Matter fell on the Ship burning with that Violence, as not to be extinguish'd with Water till it was all burnt out, smelling strongly like fired Gunpowder; and when they came to observe the Stars at Night, they found the Polarity or Direction of their Sea-Compasses to be changed; the North-Point being turned to the South, and so continued to do for the rest of the Voyage for a 1000 Leagues. He adds farther, that one of these Compasses continues to do so still, and was upon his Table before him at the time of his writing this present Letter. He makes a *Quere* whether this may be accounted for by Mr. *Boyl's* Experiment of heating a Loadstone red-hot, and by altering the Position in which it was cool'd, he could change its Polarity. Which some may say, might happen to this Needle, supposing it was made red-hot, and turned upon its Center in the Storm.

From *Thunder* he proceeds to *Earth-Quakes*, which tho' he says they have not done with them the Mischiefs frequent in *Sicily, Italy, &c.* yet they have had several very sensible and affrightning. In the Year 1663, they had 6 or 7 violent shakes in the space of 3 Days: a Town lying on the River *Connecticut*, has had scores of them in a Year, for many Years together. The *Indians* affirm, that several Rivers have not only been stopt in their course and diverted, but some wholly swallowed up by *Earth-Quakes*. He farther adds, a passage out of *Josselin* who dwelt in the Neighbourhood, that in the Year 1670, at a place called *Kenebunch*, near the side of the River, a piece of clay Ground was thrown up over the tops of high Oaks, growing between it and the River, which it thereby stopt, and left a Hole in the Place from which it was thrown forty Yards square, &c. Next as to Storms of Hail, he relates that they have had very extraordinary ones, insomuch that they have lain 3 or 4 Foot thick on the Ground,  
some

some as big as Hens Eggs, others five times as big. He mentions, as an Accident sometimes happening to them in the Winter, that it has rain'd plentifully, and at Night frozen so extremely, that the weight of the Icicles has broken the Limbs of the Trees, and not unfrequently split their Trunks. Tho' they have not those *Hurricanes* to which the *Caribbe* Islands are subject; yet they have had *Whirlwinds*, or Gulls, drive along a particular narrow Tract, for divers Miles together, with a violence not to be opposed by any thing on Earth; that if their Towns had stood in the way, they must undoubtedly have been destroy'd. Of these, he says, a thick dark, small Cloud has arose, with a Pillar of Light in it, of about 8 or 10 Foot Diameter, and past along the Ground in a Track not wider than a Street, horribly tearing up Trees by the Roots, blowing them up in the Air like Feathers, and throwing up Stones of a great weight to a considerable height in the Air, throwing down all in its passage; the Noise this Cloud made was so great all the while, that the Noise of the Mischiefs done by it, was thereby quite drown'd.

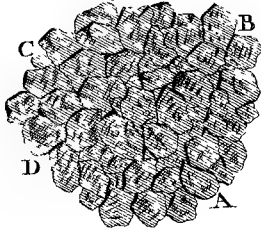
The remainder of this Letter relates to some very ancient Remains, at a Place call'd *Ammuskeag*, a little above the hideous Falls of *Merimack* River. There is a huge Rock in the midst of the Stream, on the Top of which are a great number of Pits, made exactly round, like Barrels or Hog-sheads of different Capacities, some so large as to hold several Tuns; the Natives know nothing of the Time they were made; but the Neighbouring *Indians* have been wont to hide their Provisions in them, in their Wars with the *Maquas*; affirming, God had cut them out for that use for them. They seem plainly to be artificial.

In the next place, he gives an account of a strange Inscription found on a Rock, in these Words. *At Taunton, by the side of a Tiding River, part in part out of the River, there is a large Rock, on the perpendicular side of which, next to the Stream, are 7 or 8 Lines, about 7 or 8 Foot long, and about a*  
Foot

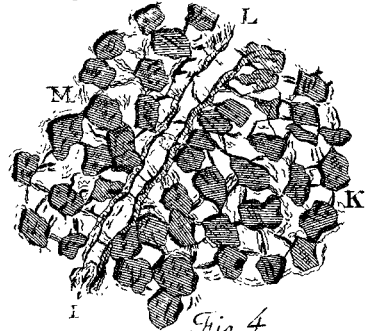
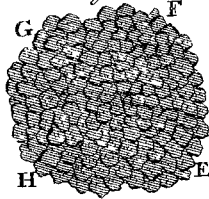
*Foot wide, each of them ingraven with unaccountable Characters, not like any known Character.* He has not yet been able to procure the whole, which he hopes to be Master of before long, and has herewith sent a Copy of two of them, promising the rest; they are as is represented, *Fig. 8.*

The last Letter of this Collection, dated *Nov. 29. 1712.* gives a Calculation of the possible Increase of the Descendants of *Adam*; and from this Introduction proceeds to the Account of some long-liv'd Persons there, as likewise of their Fruitfulness. He says, 'tis no rare thing with them to have an aged Gentlewoman see many more than 100 of her Offspring. He mentions one Woman that had 23 Children, of which 19 liv'd to Man's Estate. Another that had 27; another 26, of which 21 were Sons, one whereof was *Sir William Phipps*; another 39 Children. Here he gives several Instances of Persons living, with them, to above 100 Years of Age. One *Clement Weaver* lived to 110, his Wife being upwards of 100. This Man, to the last Year, could carry a Bushel of Wheat to the Mill, above 2 Miles. He relates the Case of an old Man, above 100, that lost the memory of several of the latter Years of his Life, but very well retain'd the Remembrance of what past in his younger days. I do not find, by any of these Relations, that the Persons observ'd any Regularity, or Method, in their manner of Diet, Exercise, or the like.

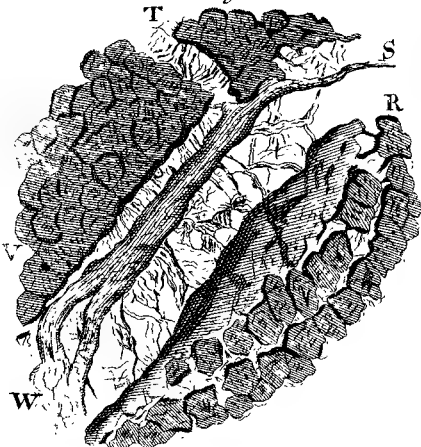
*Fig. 1.*



*Fig. 2.*



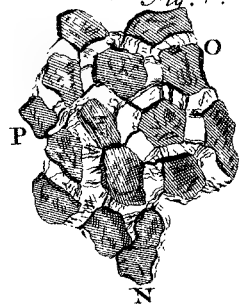
*Fig. 5.*



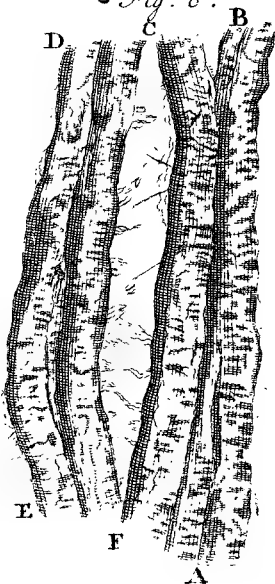
*Fig. 7.*



*Fig. 4.*



*Fig. 6.*



*Fig. 8.*



V. *An Account, or History, of the Procuring the SMALL POX by Incision, or Inoculation; as it has for some time been practised at Constantinople.*

*Being the Extract of a Letter from Emanuel Timonius, Oxon. & Patav. M. D. S. R. S. dated at Constantinople, December, 1713.*

*Communicated to the Royal Society by John Woodward, M. D. Prof. Med. Gresh. and S. R. S.*

THE Writer of this ingenious Discourse observes, in the first place, that the *Circassians, Georgians*, and other *Asiatics*, have introduc'd this Practice of procuring the *Small-Pox* by a sort of Inoculation, for about the space of forty Years, among the *Turks* and others at *Constantinople*.

That altho' at first the more prudent were very cautious in the use of this Practice; yet the happy Success it has been found to have in thousands of Subjects for these eight Years past, has now put it out of all suspicion and doubt; since the Operation having been perform'd on Persons of all Ages, Sexes, and different Temperaments, and even in the worst Constitution of the Air, yet none have been found to die of the *Small-Pox*; when at the same time it was very mortal when it seized the Patient the common way, of which half the affected dy'd. This he attests upon his own Observation.

Next he observes, they that have this Inoculation practised upon them, are subject to very slight Symptoms, some being scarce sensible they are ill or sick; and what  
is

is valued by the Fair, it never leaves any Scars or Pits in the Face.

The Method of the Operation is thus. Choice being made of a proper Contagion, the Matter of the Pustules is to be communicated to the Person proposed to take the Infection; whence it has, metaphorically, the name of Infection or Inoculation. For this purpose they make choice of some Boy, or young Lad, of a sound healthy Temperament, that is seized with the common *Small-Pox* (of the distinct, not Flux sort) on the twelfth or thirteenth day from the beginning of his Sickness: they with a Needle prick the Tubercles (chiefly those on the Shins and Hams) and press out the Matter coming from them into some convenient Vessel of Glass, or the like, to receive it; it is convenient to wash and clean the Vessel first with warm Water: A convenient quantity of this Matter being thus collected, is to be stop'd close, and kept warm in the Bosom of the Person that carries it, and, as soon as may be, brought to the place of the expecting future Patient.

The Patient therefore being in a warm Chamber, the Operator is to make several little Wounds with a Needle, in one, two or more places of the Skin, till some drops of Blood follow, and immediately drop out some drops of the Matter in the Glass, and mix it well with the Blood issuing out; one drop of the Matter is sufficient for each place prick'd. These Punctures are made indifferently in any of the fleshy Parts, but succeed best in the Muscles of the Arm or *Radius*. The Needle is to be a three-edg'd Surgeon's Needle; it may likewise be perform'd with a Lancet: The custom is to run the Needle transverse, and rip up the Skin a little, that there may be a convenient dividing of the Part, and the mixing of the Matter with the Blood more easily perform'd; which is done, either with a blunt Stile, or an Ear-picker: The Wound is cover'd with half a Walnut-shell, or the like Concave Vessel, and bound over, that the Matter be not rub'd off by the Garments; which is all



removed in a few Hours. The Patient is to take care of his Diet. In this place the Custom is to abstain wholly from Flesh and Broath or 20 or 25 days.

This Operation is perform'd, either in the beginning of the Winter, or in the Spring.

Some, for caution, order the Matter to be brought from the Sick by a third Person, lest any infection should be convey'd by the Cloaths of the Operator; but this is not material.

As to the Process of this Matter, in respect of the *Idiosyncrasie*; the *Small-Pox* begins to appear sooner in some than in others, in some with greater, in others with lesser Symptoms; but with happy Success in all. In this Place the Efflorescence commonly begins at the end of the seventh day, which seems to favour the Doctrin of *Crisis*.

It was observ'd, in a Year when the common *Small-Pox* was very mortal, that those by Incision were also attended with greater Symptoms. Of 50 Persons, who had the Incision made upon them almost in the same day, four were found in whom the Eruption was too sudden, the Tubercles more, and Symptoms worse. There was some suspicion, that these four had caught the common *Small Pox* before the Incision was made. It is enough for our present purpose, that there was not one but recovered after the Incision: In those four the *Small-Pox* came near the confluent sort. At other times the inoculated are distinct, few and scatter'd; commonly 10 or 20 break out; here and there one has but 2 or 3, few have 100: There are some in whom no Pustule rises, but in the Places where the Incision was made, which swell up into purulent Tubercles; yet these have never had the *Small-Pox* afterwards in their whole Lives; tho' they have cohabited with Persons having it.

It is to be noted, that a no small quantity of Matter runs for several days, from the place of the Incision.

The Pocks arising from this Operation are dry'd up in a short time, and fall off, partly in thin Skins, and partly  
con-

contrary to the common sort, vanish by an insensible wasting.

The Matter is hardly a thick *Pus*, as in the common, but a thinner kind of *Sanies*; whence they rarely pit, except at the place of the Incision, where the Cicatrices left are not to be worn out by time, and whose Matter comes near the nature of *Pus*.

If an Aposteme breaks out in any (which Infants are most subject to) yet there is nothing to be fear'd, for it is safely heal'd by Suppuration. If any other Symptom happens, 'tis easily cur'd by the common Remedies.

Observe, they scarce ever make use of the Matter of the Incisious Pox. for a new Incision. If this Inoculation be made on Persons who have before had the *Small-Pox*, they find no alteration, and the places prick'd presently dry up; except in an ill Habit of Body, where possibly a slight Inflammation and Exulceration may happen for a few days.

To this time, he says, I have known but one Boy, on whom the Operation was perform'd, and yet he had not the *Small-Pox*, but without any mischief; and some Months after catching the common sort, he did very well. It is to be observ'd, that the places of the Incision did not swell. I suspect this Child prevented the insertion of the Matter, for he struggled very much under the Operation, and there wanted help to hold him still. The Matter to be inserted will keep in the Glass very well for 12 Hours. He goes on.

I have never observ'd any mischievous Accident from this Incision hitherto; and altho' such Reports have been sometimes spread among the Vulgar, yet having gone on purpose to the Houses whence such Rumors have arisen, I have found the whole to be absolutely false.

It is now eight Years since I have been an Eye-witness of these Operations; and to give a greater Proof of the Sedulity I have used in this Disquisition, I shall relate two Histories.

There

There was, in a certain Family, a Boy of 3 Years old, afflicted with the *Falling-Sickness*, the *King's-Evil*, an *Hereditary Pox*, and a long *Marasmus*. The Parents were desirous to have the Incision made upon him; the *Small-Pox* were thrown off with ease; about the 40th day he dy'd of his *Marasme*. In another Family, a Girl of 3 Years old, troubled with the like Fits, strumous, attended with an *Hereditary Lues*, and labouring under a colliquative Looseness for three Months. The Operation was perform'd on this Child; she came off very well of the *Small-Pox*, which was all over the 15th day; on the 32d she dy'd of her Looseness, which had never left her the whole time.

But it is true, I never maintain'd the Inoculation as a *Panacea*, or Cure for all Diseases; nor do I think it proper to be attempted on Persons like to die. Some more quick-sighted, imagin'd these two Children were, as useleſs Shades, sent to *Charon* by any means that could be made use of. If I could have collected any more concerning this Matter, I should have imparted it candidly.

The rest of Dr. *Timone's* Letter contains his Reasons for this Method of Practice; which being the *Ætiological* Part, is publish'd in his own Words, as follows.

## Æ T I O L O G I A.

**C**ontagium Variolarum per puris infusionem propagari haud equidem mirabitur qui *Æsculapii templum* vel à primo limine salutavit, & fermentationis doctrinam subodoratus est: Nec obscurior est insitionis modus, quàm panificium, aut ars cerevisiaria, in quibus ex admixto fermento massæ fermentandæ turgescunt; conciliato nimirum motu intestino minimarum particularum principiis active pollientium. Si quis querit interim cur variolæ periculosæ alioquin & persæpe lethales, ex insitione sine ullo periculo excludantur. Dico: Variolæ communes vel concurrente pravâ aliquâ speciali aeris diathesi suscitantur, vel ab effluviis à varioloso  
cor-

corpore emanantibus per contagium propagantur. Primus casus in paucis individuis accidit, & concurrente quidem vel insigni cacochymia, vel saltem variolosi seminii in talibus individuis latitantis acerrimâ exaltatione: Secundus casus communissimus est. In primo casu miasma malignum aereum, in secundo virulenta contagii corpuscula indolis (probabiliter) salino-sulphureæ sed specificam fracedinem seu ranciditatem nacta statim ac per respirationem hauriuntur spiritus ipsos, & labe quidem teterrima inficiunt; subsequenter autem massam sanguineam & lympham vitari manifestum est. Spiritus statim infici rationi consentaneum est, tum quia in fontes spirituum, cor scilicet & cerebrum, statim ingressum habent virulentem aporrie, tum ratione analogismi inter miasmata & effluvia ista ipsosque spiritus, cum utraque spirituo-aereæ texturæ sint. Deducitur etiam cita & prava spirituum infectio à tot tantisque nervosi systematis symptomatibusque, quæ malas plerumque comitantur variolas, & præcipue à convulsionibus epilepticis quæ infantibus accidunt ipso momento, quo varioloso inficiuntur contagio multo antequam febris illos corripiat. Massam autem sanguineam inquinari præter febrem purulenta tuberculorum exclusio testatur. Lymphæ verò vitiatæ fidem faciunt glandularum in faucibus tumor, screatus, & enormis multoties pyralismus. Inter hæc circularis etiam sequitur noxa. Sed præcipue sanguinis particule ab indebita spirituum irradiatione in plures ataxias & anomalias perducuntur. Duobus tamen potissimum modis in variolis communibus mortem contingere observavi.

Primus est quando paucis erumpentibus variolis, & tardè ad maturitatem procedentibus, mala alia oboriuntur symptomata; secundus quando nimia tuberculorum copia cadaverosam putredinem inaucit. In primo casu malignæ vulgo dicuntur variolæ: causa autem est vel nimia fustio & dissolutio massæ sanguineæ, vel ejusdem coagulatio & grumescencia. Si enim impetus spirituum explosivus iusto plus augeatur, particule massæ sanguineæ nimium ad invicem atteruntur, comminuantur, & tenuissimas nanciscuntur acrotitas: sanguis in hoc statu sollertis naturæ mechanismum eludit, cumque nil sæculentioris in glandulis secretoriis cribrisque deponat, æconomie animalis functionibus requisitas filtrationes & transcolati-

ones celebrari haud patitur: improporcionata etenim est figura particularum liquidi ad configurationem pororum in tubulis & colatoriiis ratione subtilitatis nimia: filtratione enim defaecarentur particula sanguinis si naturalem servarent schematismum & molem: hinc dicitur pessim fieri per incrassationem. Præter hoc celeritas ipsa transiūs sanguinis in causa est ut nihil deponatur in colatoriis. Torrens ubi nimio impetu & præcipiti cursu fertur aquas turbidas defaecari haud patitur; quia vis centripeta gravitatem admixti terre sequens superatur à fortiorum pulsoria virtute aqueorum globulorum rapide ruentium: virtus enim fortis, verbi gratia, ut unum non poterit lineam perpendicularem describere ubi virtus fortis ut duo ad lineam horizontalem protrudit: sic etiam haud pluit vento flante intensissimo; eadem geometrica proportionem (probabiliter loquendo) sanguinis particula aucto ab effranibus spiritibus motu, tubulos colatorios prætersuunt nullâ factâ facum depositione. Hæc probabilia fiunt à summa pulsus celeritate, febre intensissima, sudore nullo, & urina cruda. E contra quandoque contingit ut ab acutis, & scindentibus deleterii fermenti particulis frangatur, corrodatur, vel saltem relaxetur elater spirituum: elanguescente igitur spirituum motu torpidiores etiam hebetioresque fiunt sanguinis lymphæque particule: igitur dum in labyrinthis tubulorum anfractibus moram indebitam contrahunt alias turmatim invicem complicari, alias autem, congestione factâ, super alias incidere, & diverso ad invicem superficierum suarum contactu à naturali configuratione desciscere, & novas induere angulorum dimensiones necesse est. Sic igitur diversa ab illa, quam superius narravimus, figurarum ad tubulorum meatus improporcionem, pari tamen calamitatis eventu dedaleæ naturæ machinationes irritas fieri contingit. Hæc probabilia fiunt à pulsu tardo & raro, ac febris carentia quandoque in summa malignitate observatis, paucis & tardè erumpentibus voriolarum pustulis. Ulterius à trepidatoria, seu sultoria ac tumultuosa furentium spirituum irradiatione inæqualis eodem tempore in diversis partibus massæ sanguineæ, & arteriarum etiam venarumque contingere potest impulsus. Sive igitur fibrilla aliquæ (ut quidem volunt) reperiantur in sanguine, seu chyli nondum bene assimilati sint portiones usibus peculiaribus dica-

dicatæ; probabiliter istarum motum turbari contingit: has enim in circulatorio motu secundum longitudinem suam naturaliter moveri necesse est: ab inæquali autem pressione dicta rectilineam figuram perdere, & in spiras ac semicirculos crispari coguntur: has igitur sic contortas transversaliter postmodum in circulatione raptari, ad invicem implicatas convolvi, & ramosis schematibus abortis, racematim adeo conglobari necesse est, ut in majusculos tandem grumos coalescant, sive demum fibrillæ illæ non dentur, cerè cujuscumque figuræ sint massæ sanguinæ particule, illas à naturali desciscere situatione ex hac motûs inæqualitate contingit: Confusæ igitur particula istæ & ad invicem implicatæ statim vehiculi sui, serî scilicet globulis per expressionem à suo contubernio explosis, majorem, ratione molis auctæ gravitatem nanciscuntur, ideoque impulsivæ circulatoriæ facultatis vim superant: Has igitur hîc illic restitare ac stagnare necesse est, prout in hoc vel illo loco prima mutua cohesio forte contigerit: Hinc livida stigmata, & simul (quod sæpe observavi in variolis cum petechiis erumpentibus) frequens sequitur mictus, quo limpidissimum serum in magna copia excluditur. En fusio, & coagulatio. Hinc mirum non est cur moriantur aliqui in variolis cum petechiis, convulsionibus syncope, vigiliis nimis, emorrhægiis, delirio, vomitibus, enormibus dysenteriis, &c. quamvis haud multa pustularum putrilagine perfundantur: In stygium enim veluti characterisum variolarum fermentum multoties evehitur, ita ut quamvis haud magnam crassi puris copiam progignere aptum sit, spiritibus tamen, liquidis & solidis suprarecensita mala modis vel explicatis vel aliis consimilibus communicare possit, sicque mortem inferre; & hoc ante undecimum plerumque. Veniamus nunc ad secundum modum. Diversa enim aliquando contingit perniciës & longè alterius generis tragædia: quamvis enim absint illa symptomata, nimia tamen puris, materiæ scilicet cadaverisatæ, copia corpus obruitur. Pus autem generari probabile est quando sulphureis oleosisque massæ sanguinæ particulis in fracedine & fusione constitutis acido-salinarum particularum coassusio contingit. Huic asserto facem accendunt innumera chymica experimenta quibus manifestè edocentur solutionibus pinguium sulphureorum per alkalia factis acido quoli-

bet coaffuso statim massam albicantis coloris emergere. Multoties igitur miasma seu fermentum variolarum per respirationem haustum ratione indolis propria acerrimæ & fortassis septica tales in massam sanguineam particularum acido-salinarum & oleoso-sulphurearum producere potest combinationes, ut non seminia solum variolarum, quæ omnibus individuis (mole tamen minima) à natiuitate indita sunt, agitentur, actuentur, & in purulentiam abeant putrilaginem, sed massa ipsa sanguinea tota acorem contrahat, & motu quodam corruptorio putrescat & cadaverisetur. Sic igitur, incendio veluti cohorto, ulterius furere fermentescentes particulas contingit, quam variolosis seminiis per despumationem eliminandis opus sit: hic motus non est depuratorius heterogeneis secernendis inserviens, sed destructivus & corruptorius, fermento nempe massam totam superante & invertente; fracidis scilicet rebellibusque particulis victoria potitis, & omnes alias in sua castra migrare cogentibus. Hoc manifestè observamus in variis potulentis, in quibus fermentatione aliquando excitatâ, motus succedit corruptivus liquores totaliter vitians: hinc videmus aliquos quamvis suprarecensitis symptomatibus immunes, immenso tamen, ut ita dicam, putredinis oceano suffocatos: Et hoc periculum usque ad vigesimum secundum protrahitur. Ultimo loco considerandum solida etiam & nobiliores partes in hisce casibus pessimè affici, & in spasmos inordinatos fieri: variis horum distortionibus tubulorum meatus vitari, at functionum munera depravari necesse est. Ecce igitur continentia, contenta, & impetum facientia, quorum triumviratu humani corporis respublica regitur, una eademque ruina ut plurimum involuta: mirabiturne quispiam malorum inde Iliadem in hominis perniciem pullulare? Observandum ulterius multis, qui peste laboraverint, communibus variolis etiam post annum correptis bubones eosdem intumuisse, qui antea in peste eruperant: nonne hoc etiam summam malignitatem testatur. Infectionem modo ad rationis trutinam revocemus. At hercule longe aliter in hoc contagionis modo rem procedere quis est qui non fateatur? Primum enim Spiritus nullatenus infici manifestum est: deinde non lymphæ, non sanguini labes illa teterrima inuritnr, non solidis vitium aliquod communicatnr. Hinc symptomata omnia levia

via, nulla pessima, nulli infantibus epileptici insultus. Contagionis enim hujusce fermentum non spiritale, non acreum & acutum est, sed humorale, iners, ac pigrum: venena autem quo subtiliora eo pejora: Ratione igitur improportionis nulla inter fermentum hoc & spiritus esse poterit lucta. Pus equidem variolarum in ipsa substantia sanguini immediatè infusum statim in largum veluti pelagus exceptum diluitur, involvitur, absorbetur, obtunditur: sic illud mitescit, sic in mansuetiorem indolem cicuratur. Contagiosæ ista particula sanguinem ingressæ statim sibi congenere variolosi seminii particulas sanguini à nativitate inditas inveniunt; iis igitur confermentescunt, sed invicem combinatæ ac complexæ haud amplius sui juris sunt ut posteriores excitent turbas, regiam vitæ petant, spirituum thesauros diripiant; nam mutuis compedibus constrictæ fixantur, precipitantur, crassioresque & hebetiores fiunt, quam antea fuerint. Statim igitur volubilioribus aquearum particularum globulis tamquam aptis vehiculis superincumbentes, sanguinis motu à centro ad peripheriam tendente, secundo veluti amne, ad ambitum corporis protruduntur, eliminantur. Nonne manifestè videmus haud pus generari in institiis variolis, sed santosam, dilutiorem videlicet aqueamque magis materiam? Nonne ex hoc phenomeno palam est acido-salinas fermenti contagiosi particulas haud oleosas passim sanguinis particulas in cadaverosam purulentiam pervertere, sed blandioribus potius levioribusque aqueis particulis easdem dilutas & saturatas foras asportari? Ex negatione fovearum & cicatricum nonne manifestum est acres, aculeatas, pungentes & corrosivas salini fermenti particulas à balsamicis statim sanguinis globulis obtundi, spiculis suis orbati, & hebetiori figura modificatas, vi veluti mochlica, extra propelli? Integra interim servatur massæ sanguineæ textura, inviolata consistentia. Nullam hîc vides fusionem, nullam grumescentiam, nullum corruptorium aut destructivum motum. In insitione enim tantum solummodo sanguis fermentescit, quantum impuro à puri consortio separando, ac per despumationem extrudendo satis est. In hoc fermentationis motu solum per undulationem quandam leviter aliquando afficiuntur spiritus, lymphæ, & solidæ partes, & siquæ ad ista

contagii



contagii particulæ perveniunt, certè (quod infitionis adumbrat metaphora) non nisi sylvestri acrimonia privata, ac velutî dulcificate pervenire possunt. Hæc tenuitatis meæ satis conscius hunc præfixta fronte obtrudo: non me latet longè meliora emanatura ab illis, quæis meliore luto finxit præcordia Titan: In historica tamen infitionis hujusce narratione aliquatenus me bene meritum spero.

Constantinopoli, Anno 1713.  
Mense Decembre.

Emanuel Timonius, Constantinopolitanus. In Universitatibus Oxoniensi & Patavina Philosophiæ & Medicinæ Doctor.

VI. *Theoremata quadam infinitam Materiæ Divisibilitatem spectantia, quæ ejusdem raritatem & tenuem compositionem demonstrant, quorum ope plurimæ in Physica tolluntur difficultates.*

A Johanne Keill, M. D. Profes. Astron. Savil. Oxon. & S. R. S.

**J**amdudum sequentia *Theoremata* in lucem emisi, omissis quidem *Demonstrationibus*, eo quod arbitrabar eas, utpote non admodum involutas, à quovis in *Geometriâ*, vel etiam in *Arithmeticâ* mediocriter versato, facile elici potuisse; Sed quoniam video, D. Christianum Wolfium in *Academiâ Fredericianâ* Mathematicum Professore, reliquosque Actorum *Lipsiensium* Authores, hæc *Theoremata* non rectè intellexisse, cumque eorum in *Philosophiâ* explicandâ usus non sit exiguus; libet ea nunc denuo, adjectis *Demonstrationibus*, Reipublicæ *Philosophicæ* impertiri.

Suppono *Materiam omnem divisibilem esse in infinitum, eamque posse formam quamcunque seu figuram induere, & ad quamcunque tenuitatem, seu crassitiem quamcunque exiguam reduci.*

*Lemma*

*Lemma.*

Datâ quâvis materiæ quantitate, ex eâ, vel ex quâvis ejus arte, formari potest sphaera concava, cujus semidiameter sit datæ rectæ æqualis.

Sit materiæ particula  $a^3$  & data recta sit  $b$ . Ratio peripheriæ circuli ad Radium sit  $p$  ad  $r$ . dicatur semidiameter concavitatis  $x$ , & crassities, pelliculæ concavitatem sphaeræ ambientis, erit  $b-x$  & Cylindrus sphaeræ circumscriptus cujus radius est  $b$  erit  $\frac{p \times b^3}{r}$ , unde sphaera cylindro inscripta

erit  $\frac{2 \times p b^3}{3 r}$ , Eâdem ratione sphaera cujus radius est  $x$  erit

$\frac{2 \times p x^3}{3 r}$  quarum differentia  $\frac{2 p \times b^3 - x^3}{3 \times r}$  ponenda est sphaericæ lamellæ æqualis, seu materiæ particulæ datæ; hoc est erit  $\frac{2 p \times b^3 - x^3}{3 r} = a^3$  seu  $b^3 - x^3 = \frac{3 r a^3}{2 p}$  unde  $x^3 = b^3 - \frac{3 r a^3}{2 p}$  &

$x = \sqrt[3]{b^3 - \frac{3 r a^3}{2 p}}$  adeoque crassities lamellæ sphaericæ seu  $b-x$

erit  $= b - \sqrt[3]{b^3 - \frac{3 r a^3}{2 p}}$ .

Eâdem ratione fieri possunt ex data materia quantitate Cubi concavi, Cylindri concavi, vel corpora etiam alterius cujusvis figuræ concavæ, quorum latera sunt data rectæ equalia.

*Theorema Primum.*

Datâ quavis materiæ quantitate quantumvis exiguâ, & dato spatio quovis finito utcumque amplo; quod v. gr. sit cubus, qui sphaeram Saturni circumscriberet: Possibile est ut materia istius Arenula per totum illud spatium diffundatur, atque

*atque ipsum ita adimpleat, ut nullus sit in eo porus cujus diameter datam superet lineam.*

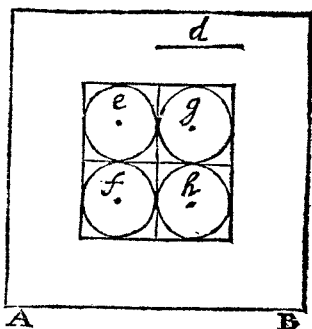
Sit datum spatium Cubus cujus latus sit recta  $AB$ , diametro scil. orbitæ Saturni æqualis, deturque materiæ particula cujus quantitas sit  $b^3$ , & data recta (quâ pororum diametri non majores esse debent) sit  $d$ . Dividi concipiatur recta  $AB$  in partes æquales rectæ  $d$ , quarum numerus finitus erit, cum nec recta  $AB$  ponitur infinitè magna, nec recta  $d$  infinitè parva: sit numerus ille  $n$ , hoc est sit  $nd = AB$ , adeoque erit  $n^3 d^3$  æqualis cubo rectæ  $AB$ . Concipiatur item spatium datum dividi in cubos quorum singulorum latera sunt æqualia rectæ  $d$ , eritque cuborum numerus  $n^3$ , & hi cubi per spatia  $efgh$  in figura represententur. Dividi porro supponatur particula  $b^3$  in partes quarum numerus sit  $n^3$ , & in unoquoque spatio cubico ponatur una harum particularum, & hac ratione materia  $b^3$  per omne illud spatium diffundetur. Potest præterea unaquæque ipsius  $b^3$  particula in sua quasi cellâ locata in sphæram concavam formari, cujus diameter sit æqualis datæ rectæ  $d$ ; unde fiet, ut sphæra quælibet proximam quamque tangat, & data materiæ particula utcunque exigua  $b^3$  spatium datum ita adimplebit, ut nullus fiet in eo porus cujus diameter datam rectam  $d$  superat.

Q. E. D.

*Cor.* Hinc dari potest corpus, cujus materia, si in spatium absolutè plenum redigatur, spatium illud fieri potest prioris magnitudinis pars quælibet data.

### Theorema Secundum.

*Possunt esse duo corpora mole equalia, quorum materiæ quantitates sint utcunque inequales, & datam quamvis ad se invicem*

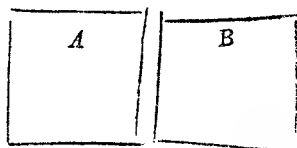


*invicem obtineant rationem, pororum tamen summa, seu spatia vacua inter corpora, ad rationem aequalitatis ferè accedant. Vel in stilo Cartesiano: Spatium omne, quod à materiâ subtili intra unius corporis poros occupatur, posset esse fere aequale spatio quod à simili materiâ intra alterum corpus tenetur. Licet materia propria unius corporis decies millies vel centies millies superat materiam propriam alterius Corporis, & Corpora sint mole aequalia.*

*Ex. gr. Sit Digitus cubicus Auri & Digitus cubicus Aeris vulgaris non condensati. Certum est quantitatem materiæ in Auro vices millies circiter superare materiam aeris, attamen fieri potest, ut spatia in auro vel absolute vacua, vel materiâ subtili repleta, sint ferè æqualia spatiis in aëre, vel vacuis, vel materiâ tantum subtili repletis.*

Sint *A* & *B* corpora duo, magnitudine æqualia: utrumque *v. gr.* sit cubus unius digiti. Et corpus *A* decies millies sit gravius corpore *B*, unde & corpus *A* quantitate materiæ decies millies superabit corpus *B*. Ponamus jam materiæ quantitatem in *A* redigi in spatium absolute plenum, quod sit digiti cubici pars centies millesima; (liquet enim ex corollæ præcedentis Theorematis id fieri posse). Unde cum materia in *A* decies millies superat materiam in *B*, materia illa in *B*, si in spatium absolute plenum compingatur, occupabit tantum digiti cubici partem  $\frac{1}{100000000}$  seu millies decies centies millesimam; Adeoque partes reliquæ 99999999 vel erunt absolute vacuæ, vel materiâ aliqua subtili, qualis supponitur Cartesiana, tantum repletæ. Porro, cum materiæ quantitas in *A* impleat tantum digiti partem centies millesimam, erunt in corpore *A* partes 9999 centies millesimæ, vel vacuæ, vel materia subtili repletæ, hoc est reducendo fractionem ad denominatorem prioris fractionis, erunt in *A* partes vacuæ 99990000 millies decies centies millesimæ. Adeoque vacuitates in *A* erunt ad vacuitates in *B*, ut numerus 99990000 ad numerum 99999999, qui numeri sunt ad se invicem ferè in

ratione



ratione æqualitatis, nam eorum differentia, parvam admodum ad ipsos numeros obtinet rationem. Adeoque spatia vacua, vel materiâ subtili tantum repleta, quæ sunt in duobus corporibus *A & B*, eandem cum ipsis numeris, ad se invicem rationem obtinentes, sunt etiam ferè in ratione æqualitatis. *Q. E. D.*

Corpora autem omnia esse rarissima, hoc est pro mole sua parvam admodum continere materiæ quantitatem, ex diaphanorum proprietatibus certissimè constat, nam *Radii Lucis* intra vitrum, vel aquam non secus ac in aere per rectas lineas diffunduntur; quæcunque luci exposita sit corporis Diaphani facies; Adeoque a minimâ quâvis assignabili Diaphani parte, ad aliam quamvis ejusdem partem, semper extenditur in his corporibus porus rectilineus, per quem transiverit lux, atque hoc fieri non potest nisi Materia Diaphani ad ejus molem, parvam admodum obtineat rationem, nec fortasse materiæ quantitas in vitro, ad ejus magnitudinem majorem habet rationem, quam magnitudo unius Arenulæ ad totam Terreni orbis molem: Hoc autem non esse impossibile, superius ostensum est. Unde cum Aurum non sit octuplo densius Vitro; ejus quoque materia, ad propriam molem, exigua admodum obtinebit rationem.

Hinc ratio reddi potest, cur effluvia magnetica eadem ferè facilitate densum Aurum & tenuem aerem pervadunt.

Ex his etiam propositionibus, & ex maximâ lucis celeritate, ratio reddi potest, cur *Lucis* radii ex pluribus objectis prodeuntes & per tenue foramen transmissi, se mutuo non impediunt, sed per eandem rectam in motu suo perseverant: Quod per motum seu impulsu fluidi, plenum efficientis, vix explicari potest; *corpus enim omne à pluribus potentiis, secundum diversas directiones, simul impulsu, unam tantum & determinatam directionem accipit ex omnibus compositam.*

# PHILOSOPHICAL TRANSACTIONS.

---

For the Months of July, August and September 1714.

---

## The CONTENTS.

- I. **O**bservationes occultationis Stella  $\tau$  in origine cornu Borei. Tauri, sub disco Luna; simulque Eclipses Luna statim infecuta, Anno 1713. Novemb. 21. mane St. vet. Romæ habitæ, & à præstantissimo Astronomo D. Francisco Blanchino. R.S.S. communicata. Cum Emerfionibus nonnullis Intimi Jovialium ex umbra Jovis, ibidem eodem anno observatis.
- II. Johannis Keill, M. D. & in Academia Oxoniensi Astronomiæ Professoris Saviliani, Observationes in ea quæ edidit Celeberrimus Geometra Joannes Bernoulli, in Commentariis Physico-Mathematicis Parisiensibus Anno 1710. De inverso Problemate Virium Centripetarum. Et ejusdem Problematis Solutio Nova.
- III. Rules for correcting the usual Methods of computing Amounts and present Values, by Compound as well as Simple Interest; and of stating Interest Accounts; by Thomas Watkins, Gent. F. R. S.

I. *Observationes occultationis Stella  $\tau$  in origine cornu Borei Tauri, sub disco Luna, simulque Eclipses Luna statim infecuta, Anno 1713. Novemb 21. mane St. vet. Romæ habitæ, & à præstantissimo Astronomo D. Francisco Blanchino. R. S. S. communicatæ. Cum Emerfionibus nonnullis Intimi Jovialium ex umbra Jovis, ibidem eodem anno observatis.*

H. post Merid.	h	"	STELLA Bayero $\tau$ Tauri proxime appellit
12	53	34	ad limbum Lunæ, observata per Telescopium duodecim palmorum.
12	54	34	Eadem jam occultata est ab ea parte Lunaribus Limbi, quæ media ferme est inter maculas Aristarchi & Galilei. Parallelus diurnus à centro Lunæ descriptus apparet Australior quam stella $\tau$ partibus Micrometri $7\frac{1}{2}$ , qualium Lunæ diameter subtendit 37. Stellæ igitur $\tau$ declinatio Borealis est declinatione apparente Lunaribus centri minutis circuli maximi $5\frac{1}{2}$ circiter.
14	0	14	Sirius attingit Meridianum: unde verificata sunt tempora.
14	32	57	Stella $\nu$ , quæ aliquot minuta excesserat è limbo Lunæ, in revolutione diurna præcedit limbum occidentalem Lunæ secundis horariis 0'. 33", eademque præcedit centrum Lunæ secundis 103" five 1'. 43".
14	42	50	Eadem præcedit limbum Lunæ secundis 48", & centrum 1'. 58".
14	50	37	Differentia Ascensionis rectæ stellæ & limbi est 1'. 03", centri vero Lunæ & ejusdem stellæ 2'. 13".
15	0	0	In limbo Lunæ Penumbra, quæ antea erat dilutior, sensim fit densior.
15	2	20	Penumbra fit evidentior, sed nondum apparet Umbra vera.
15	4	20	Initium incidentiæ Lunæ in Umbram veram, ea in parte limbi quæ proxima est maculæ Schiccardi.

Umbra

<sup>s</sup>	h	'	"	
	15	5	21	Umbra vera jam obtegit partem unam, qualium Lunæ diameter in Micrometro obtinet 37.
	15	7	20	Jam partes duæ obteguntur qualium Lunæ diameter est 37.
	15	16	20	Jam obteguntur Lunariorum diameterum $\frac{5}{3}$ .
	15	31	20	Latent Lunariorum diameterum $\frac{2}{37}$ .
	16	12	0	Jam latent in diametro partes $\frac{1}{17}$ .
	16	17	20	Partes latentes 15, ut antea.
	16	50	20	Jam partes latentes, $\frac{1}{12}$ .
	16	54	35	Incipit emergere prior limbus Tychoonis.
	16	56	9	Jam totus Tycho emergit.
	17	13	30	Latent Lunariorum diameterum partes 5 è 37.
	17	27	45	Umbra vera excedit è limbo Lunæ, in loco designato per diametrum ductam inter <i>Aristarchum</i> & <i>Platonem</i> situ inter-medio.

N. B, *Hæc observatio pluris æstimanda, quod occultatio stellæ  $\pi$  acciderit tam vicina Opposito Solis, ut inde locus Solis inter Fixas rite examinari poterit.*

*Emerfiones Satellitis intimi Jovialium ex umbra Jovis observatæ Romæ, anno 1713.*

Sept.  $\frac{11}{12}$  post meridiem 8<sup>h</sup>. 38'. 20" Intimus Jovis Satelles incipit emergere, è regione spatii inter utramque Jovis fasciam protenfi. Observatio peragebatur Telescopio D. *Andrea Chiarelli* longitudinis 40 palm. Romanorum. Deinde 8<sup>h</sup> 44'. Tertius Satelles ita apparebat Quarto conjunctus, ut ambo viderentur unicus Satelles, Distabant à centro Jovis diametris Jovialibus circiter 5  $\frac{1}{4}$ . Hora vero 9<sup>h</sup>. 4', Jam disjuncti videbantur. Quartus situ inverso apparuit paulo depressior Tertio, & paulo elongatior a Jove: quare erat Tertio Borealior.

Sept.  $\frac{1}{2}$  10<sup>h</sup>. 36". 23", Primus seu intimus Satelles incipit emergere ab Umbra, Tubo 25 Palm. Domini *Campani*.

Novemb.  $\frac{12}{13}$  7<sup>h</sup> 32' 22", Primus Satelles incipit emergere, conspectus per Tubum Domini *Chiarelli* palm. 40. Deinde eadem



dem nocte 7<sup>h</sup> 46' Primus & Secundus proximi sunt, & 7<sup>h</sup>. 53  
iidem ita sunt vicini ut vix punctulo distinguantur.

Decemb. 9 N. S. vel Novemb 28. V. S. 5<sup>h</sup>. 45'. 45", Primus  
Satelles incipit emergere ab umbra Jovis.

Decemb. 21. V. S. 5<sup>h</sup>. 50'. 22, iterum visus est primus Satel-  
les incipiens emergere ex umbra.

*Ex his observationibus accurato calculo subjectis, manifestum est  
æquationem secundam; quam a motu Luminis progressivo ortam suppo-  
nimus, necessario locum habere. Nam post 57 satellitis intimi revoluti-  
ones, quibus Jupiter a Terra plusquam Radio Orbis magni recessit,  
novem fere minutis tardius conspecta est Eclipsis ultima, quam de-  
buit juxta tenorem Observationis primæ : quod quidem Hypothesibus  
D. Cassini consonum est.*

*Ex iisdem etiam confirmatur (quod nos quoque antea anno-  
tavimus, nempe) quod motus Intimi Satellitis Jovis paulo celerior  
sit quam in Tabulis elaboratissimis D. Cassini, ante viginti annos  
cum publico communicatis, & calculi facilitate plurimum se commen-  
dantibus. Errorculus autem iste vix excedere videtur duo tempo-  
ris minuta in singulis Jovis revolutionibus, sive duodecim annis ;  
quibus cælum anticipat Cassini calculum. Hac vero adhibita cor-  
rectione, satis accuratus habebitur consensus,*

---

II. Joannis Keill M. D. & in Academia Oxoniensi Astronomia Professoris Saviliani, *Observationes in ea qua edidit Celebratissimus Geometra Johannes Bernoulli in Commentariis Physico Mathematicis Parisiensibus Anno 1710. de inverso Problemate Virium Centripetarum. Et ejusdem Problematis solutio nova.*

**N**obilissimum est problema Datâ lege Vis centripetæ invenire Curvam quam describit Mobile, de loco dato, secundum datam rectam, & cum data velocitate egrediens Concessis figurarum curvilinearum quadraturis, ejus solutionem perfectam olim dedit Dominus Newtonus in *Principiis Philosophiæ Mathematicis*. Hoc ipsum Problema denuo aggressus est vir clarissimus & Geometra celeberrimus Dominus Johannes Bernoulli in Academia Basiliensi Matheseos Professor \*, qui non pauca eaque egregia ingenii sui specimina jam pridem edidit, quibus Geometriam reconditiorem non parum ditavit. Unde a tanti viri acumine novam pulchramque Problematis solvendi methodum expectabam. Gestiebam itaque solutionem Bernoullianam perlegere, & cum Newtoniana comparare; quibus tandem diligentius perlectis & examinatis, hæc quæ sequuntur annotavi.

Dominus Bernoulli eandem præmittit propositionem quam Newtonus problemati demonstrando prius adhibuit: estque ea in *Principiis* XL, non minus pulchra quam demonstratu facilis. Scil.

Si corpus cogente vi quacunque centripeta moveatur utcumque, & corpus aliud recta ascendat vel descendat, sintque eorum velocitates, in aliquo æqualium altitudinum casu, æquales; velocitates eorum in omnibus æqualibus altitudinibus erunt æquales.

---

\* Vide Commentarios Physico-mathematicos Parisienses Anno 1710.

Hujus propositionis Demonstrationem Newtonianam ait Bernoullius esse nimis implicatam, & suam, quam simpliciorē vocat, ejus loco substituit. At pace tanti viri liceat mihi dicere, si quid discriminis sit inter demonstrationem Bernoullianam & Newtonianam, id in eo situm est, quod hæc multo facilior esse videtur minusque perplexa quam illa. *Fig. I.* Nam si centro *C* describantur circuli *DI*, *EK*, quorum intervallum *DE* est quam minimum, sintque corporum in *D* & *I* velocitates æquales, & ab *N* ad *IK* demittatur perpendicularum *NT*, fuse ostendit Newtonus vim acceleratricem secundum *DE*, esse ad vim acceleratricem secundum *IK* ut *IN* ad *IT*. Nimirum si vis secundum *DE* vel *IN* exponatur per rectas *DE* vel *IN*, vis illa secundum *IN* resolvitur in duas *TI*, *TN*, quarum illa solum quæ est ut *TI* motum secundum directionem *IK* accelerat: accelerationes autem seu velocitatum incrementa sunt ut vires & tempora quibus generantur conjunctim. At tempora ob æquales velocitates in *D* & *I*, sunt ut viæ descriptæ *DE*, *IK*; quare accelerationes in decursu corporum per lineas *DE* & *IK*, sunt ut *DE* ad *IT* & *DE* ad *IK* conjunctim; i. e. ut *DE* quad. quod est *IN* quad. ad rectang. *IT* × *IK*. adeoque ob *IN* quad. = *IT* × *IK*, incrementa velocitatum sunt æqualia: æquales igitur sunt velocitates in *E* & *K*, & eodem argumento semper reperientur æquales in æqualibus distantiiis. Hæc est summa demonstrationis Newtoni quæ tam dilucide ab eo exponitur, ut inter propositiones elementares paucas faciliores invenies. At non sic procedit Dominus Bernoullius, sed illi sufficit dicere, Mechanicam ostendere vim secundum *DE* esse ad vim secundum *IK*, ut *IK* ad *DE*. Mechanicam etiam ostendere incrementa velocitatum esse in ratione virium & temporum conjunctim; & initio motus positis velocitatibus æqualibus tempora sunt ut viæ descriptæ *DE*, *IK*; & hinc, (argumento prorsus simili ei quo utitur Newtonus) concludit incrementum velocitatis, quod acquirit corpus dum describit *IK*, esse ad incrementum velocitatis dum describitur *DE*, ut *DE* × *IK* ad *IK* × *DE*, & proinde velocitatum incrementa ubique in distantiiis æqualibus esse æqualia.

At

At si Tyronibus facilem voluisset tradere demonstrationem, debuisset Propositionem Mechanicam citare, eamque ad præsentem casum accommodare. Et quidem pluribus verbis opus est, ut hoc fiat per theorema quod innuere videtur, in quo agitur de descensu Gravium in planis inclinatis: nullum enim est hic Planum datum quod recto corporum descensui obstat; immo tantum abest ut corpus à plano cohibeatur, ut è contra à Plano seu Tangente per vim quandam continuo retrahitur. Proculdubio igitur manifesta magis foret ejus ratiocinii vis, si demissis Mechanicæ propositionibus, rem omnem ex propriis principiis demonstrasset, uti fecit Newtonus. Nam resolvendo triang. rectang.  $KN I$  in duo triangula æquiangula, est  $KI$  ad  $IN$  ut  $IN$  ad  $IT$ , adeoque loco rationis  $IN$  ad  $IT$  ponere potuisset rationem  $KI$  ad  $IN$  vel ad  $DE$ .

Si de loco quovis  $A$  in recta  $AC$  cadat corpus, deque loco ejus  $E$  erigatur semper perpendicularis  $EG$  vi centripetæ proportionalis, sitque  $BFG$  linea curva quam punctum  $G$  perpetuo tangit; demonstrat Newtonus velocitatem corporis in loco quovis  $E$  esse ut Areæ curvilinæ  $ABGE$  latus quadratum. Adeoque si velocitas dicatur  $v$ , erit  $v^2$  ut Area  $ABGE$ : & si  $P$  sit altitudo maxima, ad quam corpus in Trajectoria revolvens, deque quovis ejus puncto eâ quam ibi habet velocitate sursum projectum ascendere possit: sitque quantitas  $A$  distantia corporis à centro, in alio quovis orbitæ puncto; & vis centripeta sit semper ut ipsius  $A$  dignitas quælibet, scil. ut  $A^{n-1}$ , Velocitas corporis in omni altitudine  $A$  erit ut  $\sqrt{nP^n - nA^n}$ .

Similiter Dominus Bernoullius ostendit, si distantia à centro dicatur  $x$ , velocitas  $v$  & vis centripeta  $\phi$ , esse  $v = \sqrt{ab - \int \phi x}$  ubi ex Quadraturis constat esse Aream  $ABGE = ab - \int \phi x$ . Perinde itaque est sive exprimatur quadratum velocitatis per Aream  $ABGE$ , sive per quantitatem huic æqualem  $ab - \int \phi x$ . Et si vis centripeta  $\phi$  sit ut  $nA^{n-1}$  seu  $n x^{n-1}$ , sit  $ab = P^n$  &

2 Vide prop. 39. & 40. Principiorum.

$\int \phi x = A^n$ , adeoque  $ab - \int \phi x$  est ut quantitas  $P^n - A^n$ .

Describat corpus Curvam  $VK$ , vi centripeta tendente ad  $C$ , deturque circulus  $VXY$ , centro  $C$  intervallo quovis  $CV$  descriptus.  $Q$  sit quantitas constans, atque  $\frac{Q}{A} = z$ . Sitque  $KI$  elemen-

tum Curvæ;  $IN$  vel  $DE$  elementum altitudinis,  $XT$  elementum arcus : demonstrat Newtonus Elementum arcus seu  $XT$

exprimi posse per hanc formulam  $\frac{Q \times IN \times CX}{AA \sqrt{ABGE - z^2}}$ . Similiter

ex præmissis Dominus Bernoullius, posito Arcu  $UX = z$ , & altitudine seu distantia  $= x$ , elementum arcus ad hanc reducit formu-

lam scilicet  $z = \frac{a^2 c x}{\sqrt{abx^4 - x^4 \int \phi x - a^2 c^2 x^2}}$ . Et primo quidem as-

pectu videbatur formula Newtoniana quodammodo simplicior Bernoullianâ, eo quod paucioribus constaret terminis ; at re diligentius exploratâ, vidi Bernoullianam formulam omnino cum Newtoniana coincidere ; nec nisi in notatione quantitatum ab ea differre. Nam si pro  $ab - \int \phi x$  ponatur  $ABGE$ , pro  $a$  ponatur  $Q$ , &  $x$  pro  $A$ ,  $a$  pro  $CX$ , &  $x$  pro  $IN$ , fit

$$\frac{a^2 c x}{\sqrt{abx^4 - x^4 \int \phi x - a^2 c^2 x^2}} = \frac{Q \times CX \times IN}{\sqrt{A^4 \times ABGE - \frac{Q^2}{A^2} A^4}} =$$

$\frac{Q \times CX \times IN}{AA \sqrt{ABGE - \frac{Q^2}{A^2}}}$  seu ponendo  $z^2$  loco  $\frac{Q^2}{A^2}$ , (quod facit Newtonus commodioris notationis gratia,) Formula Bernoulli-

ana evadit  $\frac{Q \times CX \times IN}{A^2 \sqrt{ABGE - z^2}}$  : unde constat formulam illam

non magis à Newtoniana discrepare, quam verba Latinis literis expressa differunt ab iisdem verbis scriptis in Græcis characteribus.

Post traditam generalem formulam ; descendit Dominus Bernoullius ad casum particularem, ubi vis centripeta est reciproce

procè ut quadratum distantiae; & per varias reductiones & operationes satis molestas, constructionem ostendit Curvarum quæ urgente eâ vi centripeta describi possunt, easque ad æquationes reducendo probat esse Sectiones Conicas. Deinde queritur Dominum Newtonum supponere sine demonstratione Curvas à tali vi descriptas esse Sectiones Conicas.

Impossibile est ut credat nullam Newtono notam fuisse hujus rei demonstrationem; Noverit enim eum primum & solum fuisse qui hanc omnem de vi centripeta doctrinam geometricè tractavit, quique eam ad tantam perfectionem perduxit, ut post plures quam viginti annos, parum admodum à præstantissimis Geometris ei additum sit. Noverit etiam Bernoullius Newtonum, præter generalem problematis inversi solutionem, ostendisse modum quo formari possunt Curvæ, quæ vi centripeta decrescente in triplicata distantiae ratione describuntur, adeoque alterum illum casum ignorare non potuisse. Nec profecto intelligo qua ratione Bernoullius Newtono obijciat, eum hujus casus demonstrationem prætermisisse; cum ipse non pauca sæpius proposuit Theoremata, quorum demonstrationes nusquam dedit; & quidni liceat Newtono ad alia festinanti hoc idem facere. Interim in nova *Principiorum* Editione, facilius multo & magis clara, licet tribus verbis, exeat hujus rei demonstratio, quam est Bernoulliana.

Tandem Bernoullius ut necessitatem suæ demonstrationis inversi Problematis in hoc particulari casu ostendat, hæc addit. Considerandum est, inquit, quod vis quæ facit ut corpus in Spirali Logarithmica moveatur, debet esse reciprocè ut cubus distantiae à centro; at non inde sequitur talibus viribus semper describi debere tales Curvas, cum similes etiam vires facere possunt ut corpus in Spirali Hyperbolica moveatur.

Miror sane quod Vir Cl. suspicetur Newtonum talem unquam duxisse consequentiam. Nam præter Spiralem logarithmicam, ostendit Newtonus qua ratione aliæ Curvæ, numero infinitæ & diversæ, formari possunt, quæ omnes describantur eadem vi centripeta qua Spiralis Logarithmica; interque eas reponi debet hæc ipsa Spiralis Hyperbolica, ut in sequentibus ostendemus.

Exinde

Exinde autem concludit Newtonus Sectiones tantum Conicas necessario describi debere per vim centripetam quadrato distantiae reciproce proportionalem: Nempe quod Curvatura orbitae cujuscunque ex datis velocitate, vi centripeta & positione Tangentis datur; datis autem umbelico, puncto contactus & positione tangentis, semper describi possit Sectio Conica quae curvaturam illam datam habeat. Hoc à me ostensum est in Actis Philosophicis Londinensibus Anno 1708. In hac igitur Sectione, urgente illa vi corpus movebitur, & in nulla alia; cum corpus de eodem loco, secundum eandem directionem, eadem cum velocitate, & urgente eadem vi centripeta exiens, non possit diversas semitas describere.

Liceat jam mihi Dominum Bernoullium imitari, & inversum de vi centripeta problema longe diversa methodo resolvere, & ad casum particularem applicare; ubi scilicet vis est reciproce ut cubus distantiae, simulque ostendere demonstrationem Cor. 3. prop. 41. *Principiorum* Newtoni.

Quod ut fiat, quaedam ex iis quae in Actis Philosophicis No. 317. exposui hic praemittenda sunt. *Fig. II.*

Sit *VIL* Curva quavis, quam corpus urgente vi centripeta ad centrum *C* tendente describit: hanc Curvam in duobus punctis infinite vicinis *I* & *K* tangent rectae *IP*, *Kp*, ad quas à centro demittantur perpendiculares *CP*, *Cf*; centro item *C* describantur *KE*, *ID*, & ducatur *CI*.

Erit vis centripeta ut Quantitas  $\frac{Pp}{PC^3 \times IN}$  Quod Theorema li-

cet in praedicto loco demonstravimus, ecce aliam ejus demonstrationem. Ex *K* ducantur *Km* ad *CP* & *Kn* ad *CI* parallelae. Et ob æquiangula triangula *ICP*, *IKN*, *nKm*, Item quæ ob *IKm* & *IpP* æquiangula. Erit,

$$Ip \text{ vel } IP : IK :: pP : Km$$

$$PC : IP :: Km : mn$$

$$IN : IK :: mn : nK \text{ unde ex æquo}$$

$$\text{fiet } PC \times IN : IK^2 :: pP : nK; \text{ \& erit } nK = \frac{pP \times IK^2}{PC \times IN}$$

Præterea tempus quo describitur arcus *IK* est ut  
Area

Area seu triangulum  $ICK$ , vel ejus duplum  $PC \times IK$ ; adeoque si tempus detur erit  $PC \times IK$  quantitas constans. Dato autem tempore, vis centripeta est ut lineola  $Kn$  quæ sub urgente vi illâ describitur, adeoque vis centripeta est ut lineola illa  $Kn$  ducta in quantitatem constantem  $\frac{1}{PC^2 \times IK^2}$ , hoc est,

erit vis centripeta ut  $\frac{1}{PC^2 \times IK^2} \times \frac{Pp \times IK^2}{PC \times IN}$  seu ut quantitas

$\frac{Pp}{PC \times IN}$ . Quod erat demonstrandum.

Velocitas corporis in quovis loco est ut via in minimo quovis tempore percursa directè & ut tempus illud inversè; adeoque & ut  $IK \times \frac{1}{PC \times IK}$ , hoc est, velocitas erit reciprochè ut Perpendicularis è centro in Tangentem.

Si distantia corporis à centro dicatur  $x$ , & Perpendicularis in tangentem  $p$ , erit  $IN = \dot{x}$  &  $Pp = \dot{p}$  & vis centripeta exponi potest per quantitatem  $\frac{f^4 \dot{p}}{p^3 x}$ , assumendo quantitatem quamlibet pro  $f^4$ .

Adeoque si cum Domino Bernoullio vim centripetam nominemus  $\varphi$ , erit  $\frac{f^4 \dot{p}}{p^3 x} = \varphi$  &  $\frac{f^4 \dot{p}}{p^3} = \dot{x} \varphi$ ; & capiendo harum quantitatum fluentes erit  $\frac{f^4}{2p^2} =$  Fluenti quantitatis  $\dot{x} \varphi$

At cum velocitas corporis sit reciprochè ut perpendicularis  $p$ , ejus quadratum exponi potest per  $\frac{f^4}{2p^2}$ . Si itaque velocitas

dicatur  $v$ , erit  $v^2 = \frac{f^4}{2p^2} =$  Fluenti quantitatis  $\dot{x} \varphi$ . Quod si  $A$  sit locus de quo cadere debet corpus ut acquirat in  $D$  vel  $I$  veloci-



velocitatem  $v$ , deque loco corporis  $D$  erigatur perpendicularis  $DF = \varphi$  erit rectangulum  $DE \times DF = x \varphi$ . Sit jam  $BFG$  linea curva cujus ordinatæ exponant vires centripetas, seu quantitates  $\varphi$ . Fluens quantitatis  $x \varphi$  erit Area curvilinea  $ABFD = v^2 = \frac{f^4}{2p^2}$ , adeoque erit  $v$  ut Areæ  $ABFD$  latus quadratum. Quod si velocitas ea sit quæ ab infinita distantia cadendo acquiritur, erit  $v^2$  seu fluens ipsius  $x \varphi$  æquale areæ  $ODFO$  indefinitè protensæ.

Hinc semper dabitur quantitas  $p$  in terminis finitis, quando Area illa curvilinea terminis finitis exponi potest. Sit, verbi gratia, vis centripeta reciproce ut distantie dignitas  $m$ , hoc est, sit  $x \varphi = \frac{g x}{x^m}$ . Si velocitas corporis sit ea quæ acquiritur

cadendo ab infinita distantia, erit  $v^2 = \frac{g}{m-1 \times x^{m-1}} = \frac{f^4}{2p^2}$  & in

hiscæ omnibus casibus Area indefinitè protensa est quantitas finita. Potest autem corpus in trajectory revolvî velocitate cujus quadratum vel majus fieri potest, vel minus quantitate

$\frac{g}{m-1 \times x^{m-1}}$ , vel huic æquale. Adeoque erit  $v^2 = \frac{f^4}{2p^2} =$

$$\frac{g}{m-1 \times x^{m-1}} + e^2$$

Hinc urgentibus his viribus, tria Curvarum genera describi possunt; prout  $e^2$  est quantitas positiva vel negativa vel nulla.

*P. G.* Si Velocitas major sit ea quæ acquiritur ab infinita distantia cadendo, sit  $\frac{f^4}{2p^2} = \frac{g}{m-1 \times x^{m-1}} + e^2$ : si velocitas sit minor

erit  $\frac{f^4}{2p^2} = \frac{g}{m-1 \times x^{m-1}} - e^2$ : si æqualis, erit  $\frac{f^4}{2p^2} = \frac{g}{m-1 \times x^{m-1}}$

Sit

Sit  $\frac{1}{2} f^4 = a^2 e^2$  &  $\frac{1}{m-1} \times g = b^2 e^2$ . Et si velocitas corporis sit ea quæ ab infinito cadendo acquiritur, erit  $p^2 = \frac{a^2 x^{m-1}}{b^2}$   
 seu  $p = \frac{a x^{\frac{m-1}{2}}}{b}$ .

At si velocitas major sit aut minor hac velocitate, fiet uti ostensum est  $\frac{f^4}{2p^2} = \frac{g}{m-1 x^{m-1}} + e^2 = \frac{\frac{1}{m-1} g + e^2 x^{m-1}}{x^{m-1}}$ . Unde pro  $\frac{1}{2} f^4$  &  $\frac{g}{m-1}$  ponendo earum valores  $a^2 e^2$  &  $b^2 e^2$ , erit  $\frac{a^2 e^2}{p^2} = \frac{b^2 e^2 + e^2 x^{m-1}}{x^{m-1}}$  seu  $\frac{a^2}{p^2} = \frac{b^2 + x^{m-1}}{x^{m-1}}$ , & fiet  $p^2 = \frac{a^2 x^{m-1}}{b^2 + x^{m-1}}$ .

Adeoquæ si Vis centripeta sit reciprocè ut cubus distantix, hoc est, si sit  $m = 3$  &  $m - 1 = 2$ . Erit  $p^2 = \frac{a^2 x^2}{b^2}$ , vel  $p^2 = \frac{a^2 x^2}{b^2 + x^2}$ , vel denique  $p^2 = \frac{a^2 x^2}{b^2 - x^2}$ .

In primo casu constat Curvam esse Spiralem Logarithmicam: nam sit  $p = \frac{a x}{b}$ , &  $b : a :: x : p$ . adeoque ob constantem rationem  $b$  ad  $a$ , erit angulus  $CIP$  ubique constans.

Fonamus jam esse  $p^2 = \frac{a^2 x^2}{b^2 + x^2}$  & ex hac suppositione tres oriuntur diversæ Curvarum species, prout  $a$  major est quam  $b$ , aut ei æqualis, aut minor. *Fig. III.*

Et primo sit  $a$  major quàm  $b$ . Centro  $C$  & ad distantiam quamvis datam describatur circulus  $HTX$ , cui rectæ  $CK$ ,  $CI$  productæ occurrant in  $T$  &  $X$ . Et est  $IN^2 : KN^2 :: IP^2 : PC^2$   
 $p$  & ita

$$\& \text{ ita } CP - PC^2 : PC^2 :: x^2 - p^2 : p^2 :: x^2 - \frac{a^2 x^2}{b^2 + x^2} : \frac{a^2 x^2}{b^2 + x^2} :: 1 - \frac{a^2}{b^2 + x^2} : \frac{a^2}{b^2 + x^2} :: b^2 + x^2 - a^2 : a^2. \text{ Qua-}$$

re erit  $\sqrt{x^2 + b^2 - a^2} : a :: IN : KN : \dot{x} : \frac{a \dot{x}}{\sqrt{x^2 + b^2 - a^2}} = KN$ . Et quoniam est  $a$  major quam  $b$ , erit  $b^2 - a^2$  quantitas negativa. Sit illa  $-c^2$ , unde fit  $KN = \frac{a \dot{x}}{\sqrt{x^2 - c^2}}$ . Dicatur radius circuli  $HT$   $h$ , & est  $CK : KN :: CT : TX$  hoc est  $x : \frac{a \dot{x}}{\sqrt{x^2 - c^2}} :: h : \frac{h a \dot{x}}{x \sqrt{x^2 - c^2}} = TX = \dot{y}$ , si arcus  $HT$  vocetur  $y$ .

$$\text{Sit } x = \frac{c^2}{z} \text{ unde } \dot{x} = -\frac{c^2 \dot{z}}{z^2} \& \frac{\dot{x}}{x} = -\frac{\dot{z}}{z}. \text{ Item erit } x^2 - c^2 = \frac{c^4}{z^2} - c^2 = \frac{c^4 - c^2 z^2}{z^2} = \frac{c^2}{z^2} \times c^2 - z^2 : \text{ unde } \sqrt{x^2 - c^2} = \frac{c}{z} \times$$

$$\sqrt{c^2 - z^2} : \text{ quibus valoribus substitutis, erit } \frac{h a \dot{x}}{x \sqrt{x^2 - c^2}} = -\frac{h a \dot{z}}{c \sqrt{c^2 - z^2}}. \text{ Sit } a : c :: n : 1. \text{ hoc est, sit } a = nc, \& \text{ fiet } XY \text{ seu}$$

$$\dot{y} = -\frac{n h \dot{z}}{\sqrt{c^2 - z^2}}. \text{ Est verò } \frac{n h \dot{z}}{\sqrt{c^2 - z^2}} \text{ ad } \frac{c \dot{z}}{\sqrt{c^2 - z^2}} \text{ ut } n h \text{ ad } c; \text{ hoc est in ratione data: adeoque eorum fluentes, si simul incipiunt, erunt in eadem ratione, hoc est erit } HT \text{ seu } y \text{ ad flu-}$$

entem quantitatis  $\frac{c \dot{z}}{\sqrt{c^2 - z^2}}$  ut  $n h$  ad  $c$ .

Quod si centro  $C$  radio  $CV = c$  describatur circulus  $VL$ , &  $CG$  fit  $= z$ , &  $no = \dot{z}$ , fiet arcus  $mn = \frac{c \dot{z}}{\sqrt{c^2 - z^2}} = \text{fluxioni arcus } Qm, \text{ quando fluxio est quantitas positiva: sed quando est nega-}$   

tiva

tiva, ejus fluens est arcus  $Vm$  prioris complementum. Arcus enim ejusque complementum eandem habent quantitatem fluxionem denotantem, diversis tantum signis affectam; quia crescente uno decrescit alter.

Hinc est  $HT$  ad  $Vm$  ut  $nb$  ad  $c$ : sed est  $CV$  ad  $CH$  ut  $Ve$ :  $HT$ , hoc est  $c : b :: Ve : \frac{b \times Ve}{c} = HT$ , quare erit  $\frac{b \times Ve}{c} : Vm :: nb : c$ , unde  $Ve : Vm :: n : 1$ .

Præterea ex natura circuli erit  $CG : CV :: CV : CT$ , quando  $mT$  circulum tangit: hoc est erit  $z : c :: c : \frac{c^2}{z} = CT = x$ . Hinc si capiatur angulus  $VCe$  ad angulum  $VCm$  ut  $n$  ad  $1$ , & producat  $Ce$  ad  $K$  ut sit  $CK =$  secanti  $CT$ , erit  $K$  punctum in Curvâ quæsitâ.

Hic obiter notandum est, si  $n$  sit numerus, hoc est, si sit  $a$  ad  $c$  vel  $a$  ad  $\sqrt{a^2 - b^2}$  ut numerus ad numerum, Curva  $VI$  fiet Algebraica: nam in hoc casu relatio  $mG$  ad sinum anguli  $VCe$  æquatione definitur, & inde habebitur relatio finis anguli  $VCe$  ad  $CT$  vel  $CK$  per æquationem determinatam, & inde demum dabitur æquatio quæ exprimet relationem inter ordinatam & interceptam à puncto  $C$  incipientem. Harum Curvarum ordines & gradus in Scala æquationum Algebraica diversi erunt pro magnitudine numeri  $n$ . In his omnibus Curvis sic descriptis Asymptoti positio hac ratione determinatur: Fiat angulus  $VC L$  ad rectum angulum ut  $n$  ad  $1$ . In eo angulo distantia corporis à centro evadit infinita. Jam quad. perpendicularis in Tangentem  $PC = \frac{a^2 x^2}{b^2 + x^2}$ , ubi  $x$  est infinita, fit  $PC =$

$\frac{a^2 x^2}{x^2}$ , seu  $PC = a$ . Ducatur itaque  $CR$  ad  $CL$  perpendicularis & æqualis rectæ  $a$ , & si per  $R$  ducatur  $RS$  rectæ  $CL$  parallela, hæc Curvam tanget ad infinitam distantiam, seu erit Curvæ Asymptotos.

Si corpus in quavis harum Curvarum descendendo, ad Apfidem imam pervenerit; Hinc rursus ascendet in infinitum,

& aliam Curvam priori similem, seu potius ejusdem Curvæ similem portionem, ascendendo describet.

Curvæ hæc possunt pluribus revolutionibus circa centrum torqueri, priusquam ad Asymptoton convergere incipiant, & motus angularis rectæ  $CK$  erit æqualis totidem rectis quot numerus  $n$  constat Unitatibus. v. g. si  $n$  sit 100, perficientur viginti quinque integræ revolutiones priusquam distantia à centro evadat infinita.

Aucto numero  $n$ , eadem manente  $a$ , minuitur  $c$ : est enim  $\frac{a}{n}$

$\Rightarrow c$  &  $\frac{a^2}{n^2} = c^2 = a^2 - b^2$ , unde fiet  $n^2 - 1 \times a^2 = n^2 b^2$ . Et pro-

inde fiet  $a^2 : b^2 :: n^2 : n^2 - 1$ ; adeoque si  $b^2$  ad æqualitatem accedat ipsius  $a^2$ , perveniet quoque  $n^2 - 1$  ad rationem æqualitatis cum  $n^2$ , & proinde augebitur  $n$  & in eadem ratione minuetur  $c$ . Ponatur itaque esse  $b^2$  fere æquale ipsi  $a^2$ ; adeo ut cum differentia sit infinite parva, fiat  $n$  numerus infinite magnus, & radius circuli  $c$  fiet infinite parvus, seu circulus in suum centrum contrahetur. At sic evanescente  $c$ , non pariter evanescit  $CT$ , si angulus  $FCM$  sit propemodum rectus: nam in omni circulo, etiam minimo, secans anguli recti est quantitas infinita. Curva itaque hæc, ob  $n$  numerum infinitum, infinitis numero revolutionibus centrum ambibit, priusquam ad Asymptoton convergere incipiet.

Evanescente autem  $c$  fit  $b = a$  &  $p = \frac{a \cdot x}{\sqrt{x^2 + a^2}}$ . Et quoni-

am in omni casu est  $y = \frac{b a \cdot x}{x \sqrt{x^2 + c^2}}$ , evanescente  $c$  fiet  $y =$

$\frac{b a \cdot x}{x^2}$ , unde capiendo Fluente fiet  $y = \frac{b a}{x}$  seu  $xy = b a = \text{data}$

quantitati. *Fig. IV.*

Hæc Curva est Spiralis Hyperbolica, quæ plures habet notabiles proprietates. Si ducatur radius quilibet  $CT$  Curvæ occurrens in  $I$ , & peripheriæ circuli in  $T$ , & ex  $C$  ad  $CT$  excitetur perpen-

perpendicularis  $CT$ , atque  $IT$  tangat Curvam in  $I$ , & rectæ  $CT$  occurrat in  $T$ : erit  $CT$  constans recta, æqualis scilicet arcui  $VE$ ; qua proprietate Logarithmicam æmulatur, cum  $CT$  Curvæ Subtangens dici possit. Sit enim Radius circuli  $CE = b$ , arcus  $VE = a$ , dicatur  $CI = x$  &  $VT$  sit  $y$ . Quia est  $ba = x \times y$  erit  $\frac{ba}{x} = y$  &  $\frac{ba}{x^2} = \frac{y}{x}$ . Porro est  $CT : CI :: TX : NK$

hoc est  $b : x :: \frac{ba}{x^2} : NK$  : quæ proinde est  $\frac{a}{x}$ . Et quoniam

est  $IN : NK :: CI : CT$ . hoc est  $x : \frac{a}{x} :: x : CT$ , erit  $CT = a$ .

Si centro  $C$ , intervallo quovis  $CG$ , describatur circuli arcus  $GF$ , hic arcus inter rectam  $CV$  & curvam interceptus erit semper æqualis constanti rectæ  $CT$  vel  $a$ . Nam quoniam est  $VL \times CF = CV \times VE$ , erit  $VL : VE :: CV : CF :: VL : GF$  unde æquantur  $VE$  &  $GF$ . Si ad  $CG$  ex  $C$  exciterur normalis  $CR = VE$  vel  $FG$  vel  $a$ , & per  $R$  agatur  $RS$  rectæ  $CV$  parallela, erit  $RS$  Curvæ Asymptotos. Nam est recta  $MS$  æqualis arcui  $GF$ , & proinde  $FS$  distantia Curvæ ab  $RS$  est semper æqualis excessui quo arcus superat suum sinum : at cum distantia crescat in infinitum, excessus ille minuetur in infinitum, & fiet tandem data quavis recta minor, & proinde  $RS$  erit Curvæ Asymptotos.

Sit jam  $b$  major quam  $a$  ; & similiter, ut in priore casu, invenietur  $KN = \frac{a}{\sqrt{x^2 + b^2 - a^2}}$  : at quoniam  $b$  superat  $a$ , erit  $c^2$

$= b^2 - a^2$  quantitas positiva, &  $KN$  fiet  $= \frac{a}{\sqrt{x^2 + c^2}}$  & ponendo

radius circuli  $HT = b$ , invenietur  $XT = \frac{ba}{x\sqrt{x^2 + c^2}}$ . Pona-

tur  $x = \frac{c^2}{z}$ , & erit  $x = -\frac{c^2}{z^2}$  &  $\frac{x}{x} = -\frac{z}{z}$ . Erit quoque  $x^2 =$

$\frac{c^4}{z^2}$  &  $x^2 + c^2 = \frac{c^4}{z^2} + c^2 = \frac{c^4 + c^2 z^2}{z^2} = \frac{c^2}{z^2} \times c^2 + z^2$  : unde

$$\sqrt{x^2 + c^2}$$

$\sqrt{x^2 + c^2} = \frac{c}{x} \times \sqrt{c^2 + z^2}$ . His itaque valoribus substituentis fit

$$\frac{b a \dot{x}}{x \sqrt{x^2 + c^2}} = - \frac{b a \dot{z}}{c \sqrt{c^2 + z^2}} = -j. \text{ Nam tale sumi potest ini-}$$

tium arcus *HT*, ut simul cum Fluente quantitatis  $\frac{-b a \dot{z}}{c \sqrt{c^2 + z^2}}$

crescat & decreascit. Fiat  $nc = a$  & erit  $\frac{n b \dot{z}}{\sqrt{c^2 + z^2}} = j$ , &

$$\frac{\frac{1}{2} n b^2 \dot{z}}{\sqrt{c^2 + z^2}} = \frac{1}{2} b j = \text{sectori } CXT.$$

Est autem  $\frac{\frac{1}{2} n b^2 \dot{z}}{\sqrt{c^2 + z^2}} : \frac{\frac{1}{2} c^2 \dot{z}}{\sqrt{c^2 + z^2}} :: n b^2 : c^2$ , hoc est in

data ratione. Adeoque erit sector *CXT* ad  $\frac{\frac{1}{2} c^2 \dot{z}}{\sqrt{c^2 + z^2}}$  sem-

per in data ratione. Harum itaque quantitatum fluentes erunt in eadem ratione, cum simul incipere ponantur. Flu-

ens autem sectoris *CXT* est sector *CVT*, & fluens quantitatis  $\frac{\frac{1}{2} c^2 \dot{z}}{\sqrt{c^2 + z^2}}$  est sector Hyperbolæ, quod sic ostenditur. *Fig. V.*

Centro *C* semiaxe transversæ *CV* = *c* describatur Hyperbola æquilatera, & ex duobus punctis vicinis *D* & *F* ordinentur ad axem conjugatum rectæ *DB*, *EF*; ducantur item *CD*, *CF*. Et incrementum seu fluxio trianguli *BCD* æquale erit *BE* × *BD* — sector *DCF*; unde sector *DCF* (qui est Fluxio sectoris *CPD*) æqualis erit *BE* × *BD* — incremento trianguli *BCD*. Et si *BC* dicatur *z*, ob Hyperbolam, est *BD*<sup>2</sup> = *BC*<sup>2</sup> + *CV*<sup>2</sup> = *z*<sup>2</sup> + *c*<sup>2</sup>: unde *BD* =  $\sqrt{c^2 + z^2}$ , & *BE* × *BD* = *z* ×  $\sqrt{c^2 + z^2}$ . Triangulum autem *BCD* est  $\frac{1}{2} z \times \sqrt{c^2 + z^2}$ , cujus fluxio est  $\frac{1}{2} \dot{z} \times \sqrt{c^2 + z^2} + \frac{\frac{1}{2} z \times z^2}{\sqrt{c^2 + z^2}}$ . Subtrahatur hæc quantitas ab *z* ×  $\sqrt{c^2 + z^2}$ , & restabit sector Hyperbolæ minimus *CDF*

$$= \frac{1}{2} z \times \sqrt{c^2 + z^2} - \frac{\frac{1}{2} z \times z^2}{\sqrt{c^2 + z^2}} = \frac{\frac{1}{2} z \times c^2 + z^3 - \frac{1}{2} z \times z^3}{\sqrt{c^2 + z^2}} =$$

$$\frac{\frac{1}{2} c^2 z}{\sqrt{c^2 + z^2}}. \text{ Adeoque fluens sectoris } C D F \text{ est } \propto \text{qualis fluenti}$$

quantitatis  $\frac{\frac{1}{2} c^2 z}{\sqrt{c^2 + z^2}}$ . Proinde erit sector  $C V D$  fluens quan-

titatis  $\frac{\frac{1}{2} c^2 z}{\sqrt{c^2 + z^2}}$ . Præterea  $D T$  recta tangat Hyperbolam

& occurrat Axi conjugato in  $T$ . Est ex natura Hyperbolæ  $B C$  :  $C V :: C V : C T$ , hoc est  $z :: c :: c : \frac{c^2}{z} = C T = x$ . At-

que hinc oritur constructio quæ sequitur. *Fig. VI.*

Centro  $C$  semiaxe transverso  $C V$ , describatur Hyperbola æquilatera  $V m$ , item circulus  $V e$ . Capiatur sector circularis  $C V e$  ad sectorem Hyperbolicam  $C V m$  ut  $n$  ad  $1$ ; tangat Hyperbolam in  $m$  recta  $T m$ , occurrens Axi conjugato in  $T$ : producat  $C e$  ad  $k$  ut sit  $C k = C T$ , & punctum  $k$  erit in Curva quæsitâ. Nempe talis est ea Curva, ut si  $C k$  dicatur  $x$ , Perpendicularis à  $C$  in tangentem ejus demissa erit semper æqualis  $\frac{a x}{\sqrt{b^2 + x^2}}$ .

Quando  $x$  est infinita evanescit  $b^2$ , & perpendicularis fit  $= a$ , & tunc coincidit  $C R$  cum  $C V$ . Si itaque capiatur in axe conjugato  $C R = a$ , & ducatur  $R S$  ipsi  $C V$  parallela, erit hæc Curvæ Asymptotos.

Si eo usque augeatur  $a$  ut fiat quantitas  $b^2 - a^2$  infinite parva, tunc evanescet  $c^2$ , & quantitas  $\frac{h a x}{x \sqrt{x^2 + c^2}}$  fit  $\frac{h a x}{x^2}$   $= j$ . Unde si capiantur harum quantitatum fluentes, habebimus  $\frac{h a}{x} = y$ , &  $h a = x y$ , hoc est rectangulum sub arcu circulari & distantia Curvæ à centro erit semper data quantitas; atque hac ratione mi-grabit curva in spiralem Hyperbolicam. Est itaque spiralis Hyperbolica Curva media seu quasi limes, inter eas Curvas quæ construuntur per sectores circulares & eas quæ construuntur per sectores Hyperbolicos. Itaque spiralis illa Hyperbolica concip-



pi potest formari vel per sectorem Circuli aut Ellipsis, vel per sectorem Hyperbolæ, cujus Axis transversus minuitur in infinitum, & in eadem ratione augetur numerus  $n$ .

Ad eum jam devenimus casum ubi velocitas corporis minor est eâ quæ acquiritur cadendo ab infinita distantia, & ubi  $p^2 = \frac{a^2 \dot{x}^2}{b^2 - x^2}$ . Et hic simili ratiocinio ac in priori casu, invenie-

tur  $KN = \frac{a \dot{x}}{\sqrt{b^2 - a^2 - x^2}}$ , ubi necesse est ut sit  $b^2$  majus quam

$a^2$ . Hinc si  $b^2 - a^2$  dicatur  $c^2$ , fit  $KN = \frac{a \dot{x}}{\sqrt{c^2 - x^2}}$ ; & proinde

$$XY \text{ seu } y = \frac{b a \dot{x}}{x \sqrt{c^2 - x^2}};$$

Sit jam  $x = \frac{c^2}{z}$ , & fiet  $\frac{\dot{x}}{x} = - \frac{\dot{z}}{z}$  seu  $\frac{b a \dot{x}}{x} = - \frac{b a \dot{z}}{z}$  &

$c^2 - x^2$  erit  $= \frac{c^2}{z^2} \times z^2 - c^2$ , quibus valoribus substitutis fit

$$\frac{- b a \dot{z}}{c \sqrt{z^2 - c^2}} = \frac{b a \dot{x}}{x \sqrt{x^2 - c^2}} = - y. \text{ Nam tale ponendum est}$$

initium arcus  $VX$ , ut simul cum fluente quantitatis

$$\frac{b a \dot{z}}{c \sqrt{z^2 - c^2}} \text{ incipiat: unde erit } \frac{\frac{1}{2} b^2 a \dot{z}}{c \sqrt{z^2 - c^2}} = \frac{1}{2} b y = \text{sectori}$$

$$cXY = \frac{\frac{1}{2} n b^2 \dot{z}}{\sqrt{z^2 - c^2}}, \text{ ponendo } n c = a. \text{ Est vero } \frac{\frac{1}{2} n b^2 \dot{z}}{\sqrt{z^2 - c^2}}$$

ad  $\frac{\frac{1}{2} c^2 \dot{z}}{\sqrt{z^2 - c^2}}$  ut  $n b^2$  ad  $c^2$ , hoc est in ratione constanti. Qua-

re harum quantitatum Fluentes sunt in eadem ratione, hoc est

Fluens quantitatis  $\frac{1}{2} b y$  seu  $\frac{\frac{1}{2} n b^2 \dot{z}}{\sqrt{c^2 - z^2}}$  erit ad fluentem quanti-

tatis  $\frac{\frac{1}{2} c^2 \dot{z}}{\sqrt{z^2 - c^2}}$  ut  $n b^2$  ad  $c^2$ . Est autem fluens quantitatis

$\frac{1}{2} h y = \text{sectori } CVX$ , & Fluens quantitatis  $\frac{\frac{1}{2} c^2 z}{\sqrt{z^2 - c^2}}$  est sector Hyperbolæ, quod sic ostenditur. *Fig. VII.*

Centro  $C$  semiaxe transverso  $CV = c$  describatur Hyperbola æquilatera, & ex duobus punctis infinite vicinis  $B$  &  $D$  ad axem ordinentur duæ rectæ  $BE$ ,  $DF$ ; ducantur item  $CB$ ,  $CD$ . Et erit Fluxio seu incrementum trianguli  $CBE = \text{triangulo } CBD + BE \times EF$ ; unde triangulum  $CBD$ , seu sector minimus  $CBD$ , erit = incremento trianguli  $CBE - BE \times EF$ . Dicatur  $CE = z$ , & erit  $BE = \sqrt{z^2 - c^2}$ , &  $BE \times EF = z \sqrt{z^2 - c^2}$ . Est quoque triangulum  $CBE = \frac{1}{2} z \sqrt{z^2 - c^2}$ ,

cujus Fluxio est  $\frac{1}{2} z \times \sqrt{z^2 - c^2} + \frac{\frac{1}{2} z \times z^2}{\sqrt{z^2 - c^2}}$ ; à quo si subtra-

hatur quantitas  $z \times \sqrt{z^2 - c^2}$ , fit sector minimus  $CBD =$

$$\frac{\frac{1}{2} z \times z^2}{\sqrt{z^2 - c^2}} - \frac{1}{2} z \times \sqrt{z^2 - c^2} = \frac{\frac{1}{2} z \times z^2 - \frac{1}{2} z \times \sqrt{z^2 - c^2}}{\sqrt{z^2 - c^2}} =$$

$$\frac{\frac{1}{2} c^2 z}{\sqrt{z^2 - c^2}} : \text{unde constat sectorem } CBE \text{ esse fluentem quan-}$$

titatis  $\frac{\frac{1}{2} c^2 z}{\sqrt{z^2 - c^2}}$ . Præterea si  $BT$  tangens Hyperbolam Axii transverso occurrat in  $T$ , ex natura Hyperbolæ fit  $CE : CV ::$

$$CV : CT, \text{ hoc est } z : c :: c : \frac{c^2}{z} = CT = x. \text{ Fig. VIII.}$$

Hinc deducimus sequentem constructionem. Centro  $C$ , semiaxe transverso  $CV = c$ , describatur Hyperbola æquilatera  $VB$ , & circulus  $CeG$  ex centro  $C$ . Ad hyperbolam ducatur recta  $CB$ , & hyperbolæ Tangens  $BT$  axi transverso occurrat in  $T$ . Capiatur circuli sector  $CVe$ , qui sit ad sectorem Hyperbolicum  $CVB$  ut  $n$  ad  $1$ . In  $Ce$  capiatur  $CK = CT$ , & erit  $K$  punctum in Curva quæsitâ, cujus perpendicularum è centro  $C$  ad Tangentem in  $K$  demissum, si  $CK$  dicatur  $x$ , est æquale

$$\frac{a v}{\sqrt{b^2 - x^2}}$$

Et in hac Curva, urgente vi centripeta quæ sit reciproce ut cubus distantiae, movebitur corpus, si secundum directionem Tangentis cum iusta velocitate exeat. Qualis autem debet esse velocitas quæ faciat ut corpus harum Curvarum quamvis describat, sic invenietur.

Cum velocitas qua corpus in trajectory quacunque movetur sit reciproce ut quantitas  $p$ , assumendo constantem quamvis  $a$ , ea semper exponi potest per  $\frac{a}{p}$ . Et si ad Axem  $CV$

ordinentur rectæ quæ sint reciproce ut cubi distantiarum à centro, seu ut vires centripetæ, & hac ratione formetur Figura curvilinea, ejus Area indefinite extensa semper exponi potest

per  $\frac{b^2}{x^2}$ , ut ex Quadraturis constat. At Area illa est ut quadra-

tum velocitatis quæ acquiritur ab infinita distantia cadendo, adeoque velocitas hoc casu acquisita erit ut  $\frac{b}{x}$ . Hinc si velo-

citas illa dicatur  $y$ , & velocitas qua corpus in Trajectory movetur dicatur  $v$ , talesque assumantur quantitates  $a$  &  $b$ , ut in

una aliqua à centro distantia sit  $y : v :: \frac{b}{x} : \frac{a}{p}$ , erit ubique

in omnibus distantiiis  $y : v :: \frac{b}{x} : \frac{a}{p} :: p : \frac{ax}{b}$ . Unde si

$y = v$ , erit  $p = \frac{ax}{b}$ , & Curva hac velocitate descripta erit Spiralis Nautica; vel Circulus existente  $p = x$  &  $a = b$ .

Si  $y$  sit major quam  $v$ , tunc  $p$  major erit quam  $\frac{ax}{b}$ ; eritque

illa, ut ex præcedentibus constat,  $= \frac{ax}{\sqrt{b^2 - x^2}}$ . Curva autem

construetur per sectorem Hyperbolicum, ut in ultimo casu ostensum fuit, ubi distantia corporis à centro per concursum Tangentis Hyperbolæ cum Axe transverso determinatur. Si

$\gamma$  sit minor quam  $v$ , at in tantilla ratione ut maneat  $b$  major quam  $a$ , Curva formabitur per eundem sectorem hyperbolicum. At distantia corporis à centro desumitur ex concursu Tangentis cum Axe conjugato:

Si sit  $\gamma : v :: p : x$ , erit in eo casu  $a = b$ , & Curva evadit Spiralis Hyperbolica, ubi est  $p = \frac{ax}{\sqrt{a^2 + x^2}}$ . Hinc si de loco

quovis projiciatur corpus secundum datam rectam, cum ea velocitate quæ sit ad velocitatem ab infinito cadendo acquisitam, ut distantia corporis à centro ad perpendicularem è centro ad lineam directionis demissam, movebitur illud corpus in Spirali Hyperbolica. Si denique sit  $v$  tantò major quam  $\gamma$ , ut sit etiam  $a$  major quam  $b$ , Curva constructur per Sectores Circulares. Atque hac ratione datâ velocitate semper determinari possit relatio quantitatum  $a$  &  $b$ , ac proinde Curva describetur in qua corpus cum illa velocitate movebitur: & vicissim data Curva, seu datis quantitativibus  $a$  &  $b$ , invenietur velocitas qua Curva illa describitur.

Omnium Curvarum Areæ (si circulum excipias) quæ urgente hac vi centripetâ describi possunt, sunt perfecte quadrabiles.

Nam primo, in spirali Logarithmica, quia est  $p = \frac{ax}{b}$ , erit

$$KN = \frac{a \dot{x}}{\sqrt{b^2 - a^2}} = \frac{a \dot{x}}{c}, \text{ ponendo } b^2 - a^2 = c^2: \text{ vid. Fig. II.}$$

adeoque erit triangulum  $CKI = \frac{\frac{1}{2} a x \dot{x}}{c}$ ; cujus Fluens est

$$\frac{a x^2}{4c} = \text{Areæ Curvæ.}$$

Si  $p$  sit  $\frac{ax}{\sqrt{b^2 + x^2}}$ , &  $a$  major quam  $b$ , ostensum est esse  $KN = \frac{a \dot{x}}{\sqrt{x^2 - c^2}}$ , unde  $KN \times \frac{1}{2} CI = \frac{\frac{1}{2} a x \dot{x}}{\sqrt{x^2 - c^2}}$ , cujus Fluens est  $\frac{1}{2} a x \sqrt{x^2 - c^2} = \text{Areæ Curvæ.}$  At si  $a$  minor sit quam  $b$ , fit  $KN =$

$\frac{ax}{\sqrt{x^2+c^2}}$ , &  $KN \times \frac{1}{2} CI = \frac{\frac{1}{2} ax^2}{\sqrt{x^2+c^2}}$ , cujus Fluens est  $\frac{ax}{2}$   
 $\sqrt{x^2+c^2} - Q = \text{Areæ Curvæ}$ . Ponatur  $x=0$ , & fiet  $\frac{1}{2} ac - Q = 0$ , unde  $Q = \frac{1}{2} ac$ , & Area Curvæ fit  $= \frac{1}{2} a \sqrt{x^2+c^2} - \frac{1}{2} ac$ .

In Spirali Hyperbolica evanescit quantitas  $c$ , & Area Curvæ fit  $\frac{1}{2} ax$ .

Si  $p$  fit  $= \frac{ax}{\sqrt{b^2-x^2}}$ , ostensum est esse  $KN = \frac{ax}{\sqrt{c^2-x^2}}$ , un-

de  $\frac{1}{2} CI \times KN = \frac{\frac{1}{2} ax^2}{\sqrt{c^2-x^2}}$ , cujus fluens est  $Q - \frac{1}{2} a \sqrt{c^2-x^2}$   
 $= \text{Areæ}$ . Fiat  $x=0$ , & erit  $Q - \frac{1}{2} ac = 0$ , seu  $Q = \frac{1}{2} ac$ ;  
unde erit Area Curvæ semper æqualis  $\frac{1}{2} ac - \frac{1}{2} a \sqrt{c^2-x^2}$ .  
Fiat  $c^2 - x^2 = 0$  seu  $c = x$ , & Area curvæ fit  $\frac{1}{2} ac$ . Unde  
si initium Aræ non capiatur ab initio ipsius  $x$ , seu ubi  $x$  est  
 $= 0$ , sed ubi  $x = c$  est maxima, hoc est si Area ab  $P$  incipiat,  
(vid. Fig. VII.) erit Area semper æqualis  $\frac{1}{2} a \sqrt{c^2-x^2}$ .

De Arcis quas describunt corpora radiis ad centrum ductis, urgente vi centripeta quæ sit reciproce ut distantiarum cubi, sequentia adnotavit Collega meus peritissimus Geometriæ Professor *Halleius*. Nempe si corpora diversos circulos vel diversas Spirales Hyperbolicas hac lege describunt; erunt aræ sectorum, tam in Circulis quam in Spiralibus illis omnibus, æqualibus temporibus descriptæ, semper æquales: Nam velocitates corporum in circulis motorum secundum hanc legem, debent esse radiis seu distantijs reciproce proportionales, adeoque arcus simul percursi erunt quoque in eâdem radorum reciproca ratione, unde statim patebit sectores simul descriptos esse æquales.

In reliquis omnibus Curvis cum sit velocitas ad velocitatem

corporis in eadem distantia in circulo moti ut  $\frac{a}{b} \times x$  ad  $p$ , (vide

Fig. III.) seu ut  $\frac{a}{x} \times IK$  ad  $KN$ ; interea dum corpus in Trajecto-

ria percurrit lineolam  $IK$ , corpus aliud in circulo in eadem distantia motum percurrent arcum  $\frac{b}{a} \times KN$ ; & Area sectoris

Circuli & Trajectoriæ simul descriptæ erunt  $\frac{b}{a} \times KN \times \frac{1}{2} CN$

&  $KN \times \frac{1}{2} CN$ , quæ duæ Areæ sunt in ratione data, scil. ut  $b$  ad  $a$ . Adeoque ubi est  $a = b$ , uti fit in Spirali Hyperbolica, Area sic descripta erit semper æqualis Areæ sectoris circularis in æquali tempore descriptæ.

November 24. 1713

III. *Rules for correcting the usual Methods of computing Amounts and present Values, by Compound as well as Simple Interest; and of stating Interest Accounts. Offer'd to Consideration, by Thomas Watkins, Gent. F. R. S.*

#### I. Of Compound Interest.

THE Supposition whereon the Method of computing by Compound Interest is founded; *viz.* That all Interest Money, Rents, &c. are or may be constantly receiv'd, and put out again at Interest, the Moment they become due, without any Charge, or Trouble, being impracticable; therefore all Computations by this Method (except of Fee-Simples or other Perpetuities) must needs be erroneous. Thus for Instance, the Amount of a Sum of Money, or Annuity, for want of Deductions out of the Profits, for the unavoidable Trouble, Charge, and Delay in the Management, will be too great: and for the same reason, the present value of a Sum of Money payable in any time to come, will be too little; also the present value of an Annuity (being only the Amount of the difference between the Annuity, and Interest of the said present value) will be too much. But in long terms of Years, as that difference becomes less so does the Error; as the term is great

Fig. I.

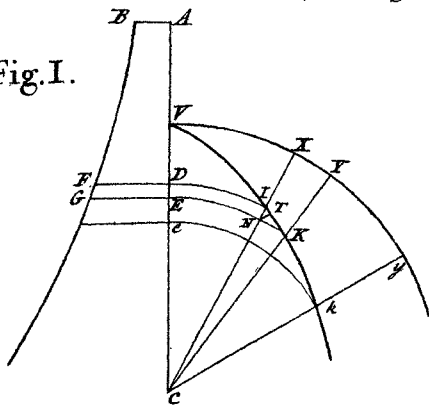


Fig. II.

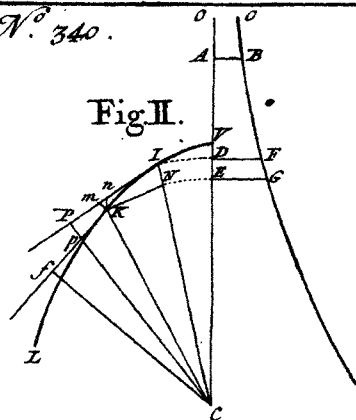


Fig. V.

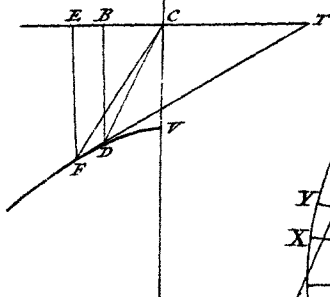


Fig. VI.

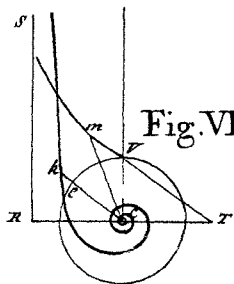


Fig. III.

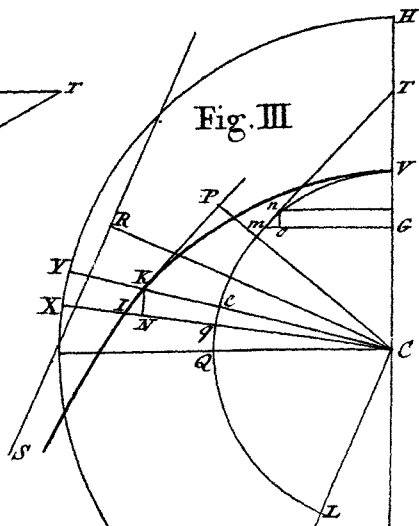


Fig. VII.

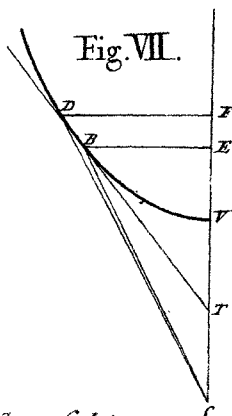


Fig. VIII.

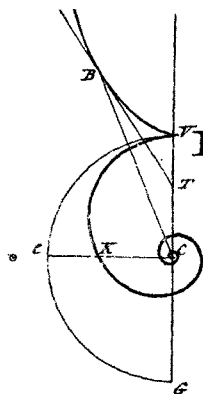
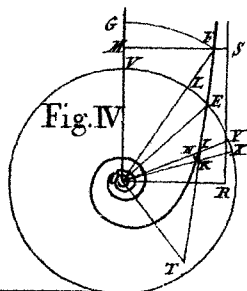


Fig. IV.



greater; and in Fee Simples it vanishes; the contrary to which happens in Amounts of Sums of Money, and Annuities.

All which is propos'd to be rectify'd, only by a just reduction of the Rate, and Annuity; (which is done by deducting so much *per Cent.* thereout, as the whole Trouble, and Charge of Management is suppos'd to amount to, and reducing the Remainder, by a Discount equivalent to the suppos'd loss of time) and then by working with the Rate so reduc'd, for Sums of Money, and with the Rate and Annuity reduc'd in the like proportion for Annuitys, according to the common Method of Compound Interest; as follows. Put  $r$  for the rate of Interest of 1  $l.$  for the Charge and Trouble of the Management of 1  $l.$  Then is  $r - cr =$  the Rate after deducting the said Charge,  $=$  (putting  $d$  for  $1 - c$ )  $dr$ . And for the Discount put  $t$  for the time lost, that is for such part of the Period of time in which the Payments are made (whether Yearly,  $\frac{1}{2}$  Yearly, Quarterly, or otherwise) as is suppos'd to be spent in receiving and putting them out again at Interest. Then,  $dtr$ , being  $=$  the Interest of 1  $l.$  for that time;

say, as  $1 + dtr : 1 :: dr :: \frac{dr}{1 + dtr} =$  (putting  $e$  for  $1 + dtr$ )

$\frac{dr}{e}$ , which is equal to the reduc'd Rate, near enough for

practice, for which put  $r$ . But if the utmost accuracy be requir'd, the Discount itself must be made with regard to the like loss of time, which is done by a Series of Discounts rais'd

thus;  $e (= 1 + tdr) : tdr :: dr :: \frac{td^2r^2}{e} :: \frac{t^2d^3r^3}{e} : \frac{t^3d^4r^4}{e^2} \&c.$

Whence  $dr = \frac{td^2r^2}{e} + \frac{t^2d^3r^3}{e^2} + \frac{t^3d^4r^4}{e^3} \&c. =$  (putting  $q$  for

$\frac{tdr}{e}$ )  $1 - q + q^2 - q^3 \&c. \times dr. = \frac{dr}{e} (= \frac{dr}{1 - q \times dr}) + \frac{q^2 - q^3 \&c.}{e}$

$\times dr$ , is  $= r$ ,  $=$  the true Rate reduced. Put  $s = 1 + r$ ,  $n =$  the time,  $p =$  the present Sum or Value,  $m =$  the Amount,

Then



Then will  $1 + \frac{dr}{e} + q^2 - q^3 \&c. \times dr \Big|^n \times p = 1 + r \Big|^n \times p = p s^n$ ,

be exactly  $= m$  : But  $1 + \frac{dr}{e} \Big|^n \times p = m$  is sufficient for practice.

And for the Amounts and present values of Annuitys.

Put  $A =$  Annuity *per annum*.

$a =$  Annuity  $\frac{1}{2}$  yearly, quarterly, &c.

$R =$  Yearly rate of Interest of 1  $l$ .

$r =$  Rate  $\frac{1}{2}$  yearly, quarterly, &c.

$t =$  Reduc'd rate yearly,  $\frac{1}{2}$  yearly, quarterly, &c.

$n =$  Number of Years,  $\frac{1}{2}$  years, quarters, &c.

Then will  $A \frac{t}{R} = a \frac{r}{r}$  be  $=$  reduc'd Annuity taken yearly

$\frac{1}{2}$  yearly, quarterly, or otherwise ; and by Compound Interest

it will be  $\frac{1+t \Big|^n - 1}{t} \times a \frac{t}{r} = \frac{1+t \Big|^n - 1}{r} \quad a = \frac{1+t \Big|^n - 1}{R} \quad A =$

$\frac{s^n - 1}{R} A = m$ , and  $\frac{s^n - 1}{R s^n} A (= \frac{m}{s^n}) = p$ . Whence the

Theorems for solving all the other Cases are easily deduc'd.

And if the Rate be requir'd, when 'tis for a Sum of Money, the Solution is obvious : when for the Amount or Value of

an Annuity, since  $\frac{1+r \Big|^n}{1+r} = \frac{mr+a}{a} = \frac{a}{a-pr}$  are the Equations

whence Theorems for the Rate are usually deriv'd, which

by this Correction become  $\frac{1+t \Big|^n}{1+t} = \frac{mr+a}{a} = \frac{a}{a-pr}$ . That

the same  $t$  may be had on both sides the Equation, put  $ut$

for  $r$ , and 'twill be  $\frac{1+ut \Big|^n}{1+ut} = \frac{mu \frac{t}{r} + a}{a} = \frac{a}{a-pu \frac{t}{r}}$  : then, by

the Rate assum'd as near the truth as may be, find the value

of  $u (= \frac{1}{d} + tr = \frac{1}{d - td\frac{t}{r}})$  and in any Theorem for the

Rate,

Rate, putting  $m u$  for  $m$ , and  $p u$  for  $p$ , the result will be the Rate reduced nearly : and by repeated Operations correcting  $r$  and thereby  $u$ , the true  $r$ , and thence  $R$  the whole Rate, may be found.

The only difficulty that remains, is the right assuming the Quantities  $c$  and  $t$ , the impossibility of doing which with perfect Exactness, I suppose to be the reason why neither this, nor any Method of Correction to the like purpose, has yet been taken notice of by the Writers on this Subject ; and what may therefore be very likely to be objected to this. But the same Objection I take to be of equal force against the Estimates of any other Uncertainties whatsoever, as Estates for Lives, Insurances &c.

First then, for the Quantity  $c$ , which is put for the Trouble and Charge of Management, *viz.* of collecting and placing out the Money on good Security, together with all Contingencies attending the same, as travelling Charges, Expences, Attorney's Bills, &c. of all which, the principal Article is the Charge of Collection or Receiver's Fees, which is commonly a fix'd Rate, customarily allow'd in the Place, or upon the Estate it self out of which the Purchase is made, if it be a Rent ; and for Interest Money, or any other Annuity, the like Estimate is to be made, whether the Proprietor acts for himself, or by another. Then for the Charge of placing out the Money at Interest when receiv'd ; though this be for the most part defray'd by the Borrower, yet because it highly concerns the Lender to see it be securely done, there are usual Allowances made to Agents and Scriveners, to encourage their Care and Fidelity therein ; besides the Time, Expence and Trouble of the Proprietor himself, in finishing Contracts, inspecting Securities &c. and whatever is sav'd in this Article, we must suppose to be fully made up by an Equivalent Degree of Risque in the Security.

In the next place, for the loss of time ; though 'tis also impossible for this to be exactly ascertain'd, nor perhaps so nearly as the former, since it depends very much on the Diligence of the Manager : Yet if the usual times of Payment  
of

of the particular Rent or Annuity to be purchased, with a moderate degree of diligence in the Manager, and the usual indulgence practis'd by Men of Business in this Case towards one another be observ'd, a reasonable Estimate may be also made of the loss of time; In which 'tis to be noted, that Interest Money being usually paid in small Sums, when any Sum of Money to be made up of several such Payments, is intended to be put out at Interest, the whole must lie dead till the last Payment be made; also that the Principal lies dead sometimes as well as the Interest; and that on the other hand, to save time, Borrowers may be found out, and treated with during the time of Collection; but this Advantage is in a great Measure lost by the difficulty of fixing the time or *Quantum* of a Loan, till the whole be paid in. Note also, that if the Charge of Collection, or Loss of time, on the Rent, or Annuity, of any particular Estate or Place, be found to differ from that of the Interest of the Purchase Money, and so much exactness be required, as that the Computation be made with regard to such difference: It must be done, either by assuming a proper Medium for both, or more accurately thus: For the reduc'd

Rate of the  $\left\{ \begin{array}{l} \text{Annuity} \\ \text{Interest-Money} \end{array} \right\}$  put  $\left\{ \begin{array}{l} 2 \\ r \end{array} \right\}$  Then  $r : 2 :: a : a \frac{2}{r}$ ,

and  $r : \frac{2}{1 + r} :: a \frac{2}{r} : \frac{1 + r^n - 1}{r} a \times \frac{2}{r} = m =$

$\frac{1 + r^n}{1 + r} \times p$ .

To give a Specimen of this Method in Numbers, first the Quantities  $c$  and  $t$  are to be assum'd, which are not here to be accomodated to any particular Place or Estate, but to be taken in general: And first for  $c$  the Charge of Management; the usual Rates of Collectors Fees in these Kingdoms, as I am inform'd, are 6*d.* 12*d.* and 18*d.* per Pound, but the most usual 12*d.* which is 5 per Cent. However to be within compass, I shall take 4 per Cent. for the Medium, including what further

R

trou-

trouble and charge may attend the Receipt of the Mony, besides Receivers Fees; and 2 *per Cent.* for all the other Charges before mention'd, in placing it out at Interest, both which make 6 *per Cent.* so that  $c$  is  $=0,06$ , and  $d (=1-c)=0,94$ . Next for  $t$  the Loss of Time; since few Annuities are paid yearly, and a Discount being given for the Loss of Time, we are to lose no more than is discounted for; therefore I choose Half-yearly Payments for the Examples, being the most usual, which with little Alteration may serve for quarterly; and considering the before-mention'd Circumstances relating to the Time, I look upon two Months the least, and seven or eight Months the most, that can well be suppos'd to be spent, one Time with another, in receiving and putting out the Mony, upon a moderate Management; between which the Medium is about four Months and half, which being  $\frac{3}{4}$  of  $\frac{1}{2}$  a Year, gives

$\frac{3}{4} = t$ : and if  $\frac{dr}{e}$  be  $= r$ , the yearly Rates of 4, 5, 6, 8 and

10 *per Cent.* will produce for Half-yearly Rates reduc'd of 1 *l.* 0.018539, 0.023093, 0.027616, 0.036569 and 0.0454 each =

$r$ . But if  $r$  be  $= \frac{dr}{e} + q^t - q^t \&c. \times dr$ , 'twill be, 0.01854219,

0.023099155, 0.027627775, 0.036596289 and 0.04545235, each =  $r$ , (so that each Rate loses by this Estimate about  $\frac{1}{12}$  Part.)

Whence the following Amounts, and present values of 1 *l. per Annum* computed Half-yearly, are produc'd, and compared with those of the usual Method computed yearly, to agree with the common Tables.

*Tears*

Years.	Amounts of 1 l. per An. at 5 per Cent. by			Differences.	Amounts of 1 l. per An. at 6 per Cent. by			Differences.
	Comp. Int.	Co. Int. cor.			Comp. Int.	Co. Int. cor.		
5	5,52563	5,13104	,39459		5,63709	5,22138	,41571	
10	12,57789	11,57846	,99943		13,18079	12,07854	1,10225	
20	33,06595	29,85996	3,20599		36,78559	32,91054	3,87505	
30	66,43885	58,72546	7,71339		79,05819	68,83976	10,21843	
40	120,79977	104,30079	16,49898		154,76197	130,80733	23,95464	
60	353,58372	289,88164	63,70208		533,12818	422,01429	111,11389	
80	971,22882	752,53436	218,69446		1746,5999	1288,2484	458,3515	
100	2610,02516	1905,92671	704,09845		5638,3680	3864,9753	1773,3927	
The same at 8 per Cent.								
5	5,86660	5,40633	,46027		6,10510	5,59705	,50805	
10	14,48656	13,15092	1,33564		15,93743	14,32680	1,61063	
20	45,76196	40,13759	5,62437		57,27500	49,17930	8,09570	
30	113,28321	95,51623	17,76698		164,49402	133,96428	30,52974	
40	259,05652	209,15737	49,89915		442,59257	340,21900	102,37357	
60	1253,2133	920,90040	332,3129		3034,81648	2062,57167	972,24481	
80	5886,9354	3918,0578	1968,8776		20474,0027	12255,3348	8218,6679	
100	27484,5157	16539,0989	10945,4168		137796,127	72575,3926	65220,7344	
The same at 10 per Cent.								

Years.	Pref. Values of 1 l. per An. at 5 per Cent. by			Differences	Pref. Values of 1 l. per An. at 6 per Cent. by			Differences
	Comp. Int.	Co. Int. cor.			Comp. Int.	Co. Int. cor.		
5	4,32948	4,08343	,24605		4,21236	3,97582	,23654	
10	7,72174	7,33314	,38860		7,36009	7,00322	,35687	
15	10,37966	9,91935	,46031		9,71225	9,30843	,40382	
20	12,46221	11,97753	,48468		11,46992	11,06373	,40619	
30	15,37245	14,91902	,45343		13,76483	13,41805	,34678	
40	17,15909	16,78200	,37709		15,04630	14,78309	,26321	
50	18,25593	17,96190	,29403		15,76186	15,57456	,18730	
70	19,34268	19,18247	,16021		16,38454	16,29953	,08501	
100	19,84791	19,79231	,05560		16,61755	16,59510	,02245	
E.S.	20,00000	20,00000	,00000		16,66666	16,66666	,00000	

*Note, That this Correction is also applicable to the Valuations of Estates for Lives, in which the first Step being to find an Equivalent in Years of Continuance, brings them to the Case of Estates for Years.*

## II. Of Simple-Interest.

The absurdity of the Supposition, on which the usual Method of computing present Values by Simple-Interest, is founded, *viz.* That the Rent or Annuity is constantly received, and put out again at Interest, as it becomes due; but that the Interest of the Purchase Money lies dead during the whole Term, is so apparent, and the Errors arising from it so gross, that the Writers who have laid down this Method, have at the same time caution'd against the Use of it for any more than 6 or 7 Years, the Error for that time being not considerable.

The same Supposition does also occasion the miscomputation of Amounts, or rather the misapplication of them to their proper Cases. Wherefore, since the Simple-Interest of Money is of equal Value *pro rata*, and of the same regard with Rents or Annuitys, being each the Original Profits issuing alike from a principal Stock, Estate or Value, and equally improveable; This general Rule may serve for a just Correction of this Method, *viz.* That supposing in any Case an Interest ought to be, or not to be allowed to either of those Profits, the same be done in the like Case to the other. Thus, in the Case of Debts, or Amounts of Sums of Money, Rents, or Annuitys for the time past, its usual in practice to allow no Interest to either: For though the Law, to curb the exorbitant Avarice of Usurers, and for other Reasons, does more expressly disallow Interest upon Interest for a Debt; our Courts both of Law and Equity, as I am inform'd, will be as far from allowing the Charge of Interest against a Tenant for Rent in Arrear; except on a *nomine pæne* (which is now become almost obsolete) so that in this Case (putting *a* and *r* for the Annuity and Rate yearly, Half-yearly, or otherwise) as  $prn + p$  is the Amount of a Sum of Money, so is  $an$  the Amount of an Annuity or Rent in Arrear, and not

$\frac{n-1}{2} r + 1 \times an$  as Arithmeticians commonly make it. But in

the Computation of present Values, or Amounts for the time to come,

come, the same being made on the Expectation of a constant regular Income of the Profits; without any extraordinary Interruption, an Interest ought to be allow'd to both, especially in present Values, which are found by setting the Amounts of both against each other: so that in these Cases, putting  $x = n - 1$ , if  $\frac{1}{2}xr + 1 \times an$ , be made the Amount of a Rent or Annuity; then  $\frac{1}{2}xr + 1 \times prn + p$ , will be the proper Amount of a Sum of Money, and not  $prn + p$ : and consequently

$\frac{\frac{1}{2}xr + 1 \times an}{\frac{1}{2}xr + 1 \times rn + 1} = p$  will be the present Value of a Rent or

Annuity, the subsequent Interest being remitted on both sides in lieu of the Loss of Time and Charge of Management; which such as are apt to depreciate long Futurities, may think the properest Method of approaching the true Value; but I rather look upon the former Method of Compound Interest corrected as more exact, as well as more general, the Interest remitted in this, being in short Terms less, and in long Terms more than an Equivalent for the Trouble, Charge and Delay in the Management. But it is however the most exact of any of the Methods, that have yet been deduc'd from Simple-Interest. The reduc'd Rate may also in some Cases be properly made use of for Amounts, but not for present Values, except for short Terms; and then, since  $r : a :: \frac{1}{2}xr + 1 \times rn :$

$\frac{1}{2}xr + 1 \times an \frac{r}{r}$ , 'twill be  $\frac{1}{2}xr + 1 \times an \frac{r}{r} = m = \frac{1}{2}xr + 1$

$\times prn + p$ , and  $\frac{\frac{1}{2}xr + 1 \times an}{\frac{1}{2}xr + 1 \times rn + 1} \times \frac{r}{r} = p$ .

Examples of this Method compar'd with those of the former, will stand as follows; in which all is computed Half-yearly, except the last Column of Compound Interest.

Amounts of 1 l. at 5 per Cent. computed 6 several Ways.

Years.	1	2	3	4	5	6
	Simple Int.	Id. for Bonds	Sim. Int. cor.	Id. by the red. rat.	Co. Int. cor.	Comp Int.
	$prn + p = m$	Id. till $prn = p$	$\frac{i \times r + 1 \times}{prn + p = m}$	$\frac{i \times r + 1 \times pr}{+ p = m}$	$i + r^n \times p = m$	$\frac{N}{+ R} \times p = m$
5	1,25	1,25	1,27813	1,25501	1,25655	1,27628
10	1,5	1,5	1,61875	1,56338	1,57892	1,62889
20	2,	2,	2,48750	2,34021	2,49300	2,65330
30	2,5	2,	3,60625	3,33048	3,93625	4,32194
40	3,	2,	4,97500	4,53419	6,21504	7,04000
60	4,	2,	8,46250	7,58194	15,49408	18,67919
80	5,	2,	12,95000	11,48345	38,62672	49,56144
100	6,	2,	18,43750	16,23874	96,29634	131,50126

Amounts of 1 l. at 6 per Cent. by the same Theorems.

5	1,3	1,3	1,3405	1,31063	1,31328	1,33822
10	1,6	1,6	1,7710	1,69758	1,72471	1,79084
20	2,2	2,	2,9020	2,70048	2,97463	3,20713
30	2,8	2,	4,3930	4,00870	5,13039	5,74349
40	3,4	2,	6,2440	5,62223	8,84844	10,28572
60	4,6	2,	11,0260	9,76525	26,32086	32,98769
80	5,8	2,	17,2480	15,12954	78,29488	105,79599
100	7,	2,	24,9100	21,71510	232,89852	339,30208

Amounts of 1 l. at 10 per Cent. by the same Theorems.

5	1,5	1,5	1,6125	1,54749	1,55970	1,61051
10	2,	2,	2,4750	2,30157	2,43268	2,59374
20	3,	2,	4,9500	4,42951	5,91793	6,72750
30	4,	2,	8,4250	7,33881	14,39643	17,44940
40	5,	2,	12,9000	11,16449	35,02190	45,25925
60	7,	2,	24,8500	21,20493	207,25717	304,48165
80	9,	2,	40,8000	34,55084	1225,5335	2048,4003
100	11,	2,	60,7500	51,20222	7258,5398	13780,6127

*Years*



Years.	Pres. Values of 1 l. per An. at 5 per Cent. by			Pres. Values of 1 l. per An. at 6 per Cent. by		
	Sim. In. cor.	Co. Int. cor.	Comp. Int.	Sim. In. cor.	Co. Int. cor.	Comp. Int.
5	4,35208	4,08343	4,32948	4,23349	3,97582	4,21236
10	7,64478	7,33314	7,72174	7,25579	7,00322	7,36009
15	10,10821	9,91935	10,37966	9,39341	9,30843	9,71225
20	11,95980	11,97753	12,46221	10,92350	11,06373	11,46992
30	14,45407	14,91902	15,37245	12,87275	13,41805	13,76483
40	15,97990	16,78200	17,15909	13,99744	14,78309	15,04630
50	16,96682	17,96190	18,25593	14,69544	15,57456	15,76186
70	18,10986	19,18247	19,34268	15,47252	16,29953	16,38454
100	18,91525	19,79231	19,84791	15,99739	16,59510	16,61755
E.S.	20,00000	20,00000	20,00000	16,66666	16,66666	16,66666

The Theorems to the preceding Columns of Amounts (of which the fourth and fifth are infinitely variable in the Result, by assuming  $c$  and  $t$  in the reduced Rates at Pleasure) may serve to answer all the simple Cases of Amounts that occur in Business: To instance in some,

1. The first Column contains the Amounts of such Debts, or Sums of Money as carry a simple Interest till the Principal be paid.

2. The second Column answers the common Case of Debts due by Bond, that by Law are allow'd not to exceed the Penalty, which is generally double the principal Debt.

3. The third Column answers the Case of a Security or joyn't Obligor, that has duly and constantly paid the Interest, and at last the principal Sum of a Debt, from which he has a Counter-Bond from the principal Debtor to save him harmless, against whom he may make his Charge from this Column.

4. In case the Parties shall agree that the Debt shall lie for any time certain, or uncertain; and for the much greater ease, advantage and satisfaction of both of them, no Interest to be call'd for, till the Principal it self is paid; but to carry Interest as it becomes due, the Lender allowing for the time and charge he must have been at, in receiving and putting out his Interest, the fourth Column will fit this Case, or else the fifth

as a greater or less degree of Lenity is agreed upon in favour of the Borrower.

5. The fifth Column is also proper in the following Case, *viz.* if it be demanded, what Estate in reversion, after a certain number of Years, any Sum in Hand will Purchase; the first step being to find the Amount of that Sum to the time the Reversion commences, its had in this Column.

6. The last Column gives the Amount of a Sum of Money, according to the common Method of Compound Interest, but being computed with that extraordinary rigor as has been said, (except some small allowance for the loss of time, by being done Yearly) 'tis hardly suitable to any Case.

Other Cases might be enumerated, to which the foregoing Theorems might be equitably apply'd; besides such extraordinary ones, wherein it may appear to Arbitrators, or a Court of Equity, that either Partie deserves Favour, either by way of Compensation for Injuries suffer'd from the other, by means of any fraudulent or oppressive Practices, or otherwise, for which no other redress is provided.

### III. Of Interest Accounts.

The Inequality of the usual Method of stating Interest Accounts, as practis'd in our Courts of Equity, will best appear by an Example, for which I shall take the common general Case of an Interest Account to be stated on a Mortgage, *viz.* suppose 1000 *l.* to be let out at 6 *per Cent.* on a Mortgage of 120 *l. per annum*, payable Half Yearly, and the Mortgagee after five Years end, to have Possession till the Arrear of Interest, accruing Interest and Principal be discharged : *Quære*, How long that will be? supposing also, for the sake of brevity in the Account, the Payments to be equally, and punctually made as they become due. By the Chancery Method, the Rent is first apply'd to discharge the Arrear of Interest; and then the remainder of every Half-Year's Rent, after deducting the same Half-Years Interest, is apply'd towards the Discharge of

of the Principal, and thereby the Principal and Interest continually lessens, till the whole be paid off. Now by this means the Mortgagee, after the Arrear is discharged, pays Comp. Interest, with the utmost rigour, for so much *per annum* of the Rent, as exceeds the Interest of the whole Principal Money, and receives but Simple Interest for his Debt; which, however strange it may seem, is easily prov'd, by applying the proper Theorems of Simple and Compound Interest to this Case, in which the Annuity, Principal Money, Rate and Arrear of Interest are given, and the time requir'd; the result being the same with that of the Chancery Method, except a very small difference only when any part of the time is express'd by a Fraction: *viz.* putting  $L$  for Logarithm,  $\alpha = a - p r = 30$ ,  $s = 1 + r = 1.03$ ,  $t =$  time of contracting the Arrear  $= 10$  Half-years,  $n =$  any number of  $\frac{1}{2}$  Years spent in discharging the whole or any part,  $N =$  number of Years required; the Equation for the Arrear will be  $p r t + p r n = a n$ ; and for the Principal and accruing Interest  $p r n + p = p r n + \frac{s^n - 1}{r} \times \alpha$ . Whence

$$\frac{p r t}{2 \alpha} + \frac{L a - L \alpha}{2 L s} = N = 16,7249 \text{ Years} = \text{the time demanded;}$$

$$\text{i.e. } \frac{p r t}{2 \alpha} = 5 \text{ Years} = \text{the time of discharging the Arrear, and}$$

$$\frac{L a - L \alpha}{2 L s} = 11,7249 \text{ years,} = \text{the time in which the Prin-}$$

incipal and accruing Interest is discharged; during which it is evident, the Mortgagee pays full Compound Interest for 60 *l.* *per annum* of the Rent. For the Correction of which inequality, in the first Place, to the end that neither Branch may exceed, or be depriv'd of its due Profits; This general Rule is propos'd as necessary to be always observ'd, *viz.* That Amounts of the Produce on each side be stated separately, and set against each other in the Account, in order to a Ballance. And in the common Cases of Mortgages, Government, and

Stock Securities, &c. where the Debt is paid off by a Rent, Annuity, Pension, Dividend, or other Payments issuing in the same manner, and with the like trouble, charge, &c. as Interest Money does; I presume this Rule will also be easily admitted, *viz.* That the same equitable Advantage be impartially allow'd on both sides; for which the Method of Simple Interest, as corrected under the foregoing Head, seems truly adapted; whereby the Original Profits on each side are suppos'd to be deem'd, either as Interest, or else as Principal Money; and since the Amounts both of an Annuity and Sum of Money, for the time past, as there stated, on the first of these Suppositions ( $t$  being there  $= 0$ ) are likewise vouch'd by our Laws, and the practice of our Courts, to be good when separately us'd; I think its very evident, that the Account ought to be stated by setting those Amounts against each other thus,

$$prt + prn + p = an, \text{ (whence } \frac{1 + tr}{2\alpha} p = N, = 21,6666$$

Years) and that this Method is most proper for general Use, in the Cases mention'd: Unless it should be thought fit, in consideration of the various Ways found out for the ready improvement of Money, to allow a further Advantage on both sides, by charging the Original Profits as Principal Money, and giving a Simple Interest there to, which still falls short of the Advantage allow'd to Rents by the Chancery Method. And this is to be done two ways, *viz.* either by applying an Amount of Rent to pay off the Arrear first, and afterwards another Amount of Rent to discharge the Principal, and accruing Interest; or else by letting the Profits with all Arrears and other Charges run on at Simple Interest on each side, till the end of the Term: *viz.* putting  $x = n - 1$ ,  $y = t - 1$ ,  $\alpha = a - pr$ ,  $f = 2 - r \times \alpha$ ,  $g = f - 2prt^2$ ,  $\mu = \frac{1}{2}yr + \frac{1}{2} \times prt = \text{Arrear of Interest}$ ; by the first of these 'twill be, for the Arrear,  $\mu + prt^2n = \frac{1}{2}xr + \frac{1}{2} \times \alpha n$ , and for the Principal and accruing Interest,  $\frac{1}{2}xr + \frac{1}{2} \times \alpha n = p$ ; Whence  
 $\sqrt{8\mu\alpha}$

$$\frac{\sqrt{8\mu ar + g^2} - \sqrt{8par + f^2} - f + g}{4ar} = N = 18,7653$$

Years. By the other 'twill be, for the whole,  $\mu + pr^2n + p =$   
 $\frac{1}{2}xr + 1 \times an$ , Whence  $\frac{\sqrt{\mu + p \times 8ar + g^2} - g}{4ar} = N =$

18,1648 Years. The Lender will have to alledge for the first of these two Ways, that as the Rent is not hindred by any other parallel Charge from making the utmost produce it can, so for that reason ought his Principal Mony to have the Advantage of the Arrears being first discharged, which also agrees with the Chancery Method in this particular.

Lastly, another way of stating this Account, may be taken from that Notion of Simple-Interest, whereby the Annuity only is charged as Principal Mony: and then 'twill be, for the Arrear,  $prt + prn = an$ , and for the Principal and accruing

$$\text{Interest, } \frac{1}{2}xr + 1 \times an = p; \text{ Whence } \frac{\sqrt{8par + f^2} - g}{4ar} (= \\ \frac{prt}{2a} + \frac{\sqrt{8par + f^2} - f}{4ar}) = N = 17,3072 \text{ Years; which}$$

appears to be same with the Chancery Method, only that the Compound Interest in that, is turned into Simple in this; and as it still retains part of the same inequality, to the Advantage of the Borrower, it seems only fit to be observed in such Cases wherein the Borrower may be thought to merit favour, as when the Debt is paid out of the Profits of Trade, arising by extraordinary Risque or Industry. But since such a Rule of distinction is hardly possible to be reduc'd to general practice, the use of this Theorem seems restrained to such Cases only, wherein the Parties themselves, or a Court of Equity shall think it reasonable.

For a further illustration of these Rules, the following Specimen is added, which shews at sight, how the Results of the several Methods differ, as the Rent, Arrear, or Rate of Interest, is greater or less, and consequently of how much more

or less concern it is to the Parties, as well as to the due Administration of Justice, to have regard thereto.

The time requir'd in —————		Years (computed Half-yearly)			
To discharge a Mort. of 1000 l. by a Rent of		120 l. per annum	90 l. per annum		
At the Rate of Int. <i>per annum</i> of —————		5 per C.	6 per C.	5 per C.	6 per C.
No Arrear of Interest.					
By the Chancery Method —————		10,9141	11,7249	16,4205	13,5335
By the same turning the Comp. Int. into Sim.					
By Simp. Int. cor. } Princ. and { contin <sup>d</sup> at Int.		11,2579	12,3072	17,5335	20,7400
the Original Pro- } the Arrear { first discharg'd					
fits charged as } Interest —————		14,2857	16,6666	25,0000	33,3333
5 Years Arrear of Interest.					
By the Chancery Method —————		14,4855	16,7249	22,6705	28,5835
By the same turning the Comp. Int. into Sim.					
By Simp. Int. cor. } Princ. and { contin <sup>d</sup> at Int.		14,8293	17,3072	23,7835	30,7400
the Original Pro- } the Arrear { first discharg'd					
fits charged as } Interest —————		15,5897	18,7653	25,4899	34,8052
10 Years Arrear of Interest.					
By the Chancery Method —————		18,0569	21,7249	28,9205	38,5835
By the same turning the Comp. Int. into Sim.					
By Simp. Int. cor. } Princ. and { contin <sup>d</sup> at Int.		18,4007	22,3072	30,0335	40,7400
the Original Pro- } the Arrear { first discharg'd					
fits charged as } Interest —————		21,2895	27,5587	36,1932	53,8107
15 Years Arrear of Int.					
By the Chancery Method —————		21,6283	26,7249	35,1705	48,5835
By the same turning the Comp. Int. into Sim.					
By Simp. Int. cor. } Princ. and { contin <sup>d</sup> at Int.		21,9721	27,3072	36,2835	50,7400
the Original Pro- } the Arrear { first discharg'd					
fits charged as } Interest —————		26,1353	34,2913	43,9764	65,8386
		28,0209	37,7141	48,5159	74,5664
		25,0000	31,6666	43,7500	63,3333

I must also observe for the sake of such as are unacquainted with specious Arithmetic, that though for brevity's sake, the foregoing Theorems and Examples are laid down, and wrought in Algebraic Terms: Yet the same Accounts may be stated after the Chancery manner it self, according to the several Principles before deliver'd, and with the same Results, with this only caution, that (instead of a continual deduction of the Rent or Annuity out of the Principal and Interest of the Debt, which occasions the Error before mention'd) the preceding General Rule of stating separate Amounts be observ'd, which may be done by continually adding the profits together on each side, in the same manner, as if the Parties were

to

to make a separate Charge against each other, which is the rather to be noted, as being the only Course that can be taken, in case the Sums or Times of payment should differ, but the respective Results will notwithstanding be analogous to the above Examples.

All which is submitted to the consideration of more discerning Judgments, especially the Applications of the Rules to particular Cases, for exemplifying the Theorems. But if any of those Rules or Theorems should be objected against, merely because they tend to introduce some Alterations in the present practice; I shall for answer only add, with submission, to what is before said, that in former Ages, when our Laws relating to these matters had their rise, (the Profits of *England* arising chiefly from Husbandry and Tillage, and little from Trade,) the Cash of the Kingdom was but low, the Rates of Interest very high to the Advantage of Usurers, and those ways for the ready Improvement of Money accomodated to all Peoples use, not known; (much like to which we are told was the State of the Jewish Affairs, when they were forbidden to take Usury of any but Strangers.) But latter Ages have produc'd vast Alterations in all these Respects, which having happen'd by insensible degrees, may be one reason why neither our Legislature, nor Courts of Judicature have yet taken such notice thereof, as time and leisure, with the Tender of proper and practical Methods of Computation, may hereafter induce them to do.

# F I N I S.

---

L O N D O N : Printed for W. I N N Y S at the *Prince's Arms* in  
St. Paul's Church-Yard. M D C C X V.





# PHILOSOPHICAL TRANSACTIONS.

For the Months of October, November and December, 1714.

## The CONTENTS.

I. *An Account of the Rain which fell every Year at Upminster in Essex, for the last 18 Years: With Remarks upon that of the last Year, 1714. By Mr. W. Derham, Rector of Upminster, and Fellow of the Royal Society. Also a Comparison of what has been observed of the same kind at Paris, by M. De la Hire.*

II. *Solutio Generalis Problematis XV. propositi a D. de Moivre, in tractatu de Mensura Sortis inserto Actis Philosophicis Anglicanis N<sup>o</sup> 329, pro numero quocunque Collutorum. Per D. Nicolaum Bernoulli Basiliensem, J. U. D. & Regiæ Societatis Sodallem.*

III. *Solutio Generalis altera præcedentis Problematis, ope Combinationum & Serierum infinitarum. Per D. Abr. de Moivre, Reg. Soc. Sodallem.*

IV. *An Account of several extraordinary Meteors or Lights seen in the Sky. By Dr. Edmund Halley, Professor of Geometry at Oxon, and Secretary to the Royal Society.*

V. *Some Remarks on the Variations of the Magnetical Compass, published in the Memoirs of the Royal Academy of Sciences, with regard to the General Chart of those Variations made by Dr. Halley. As also concerning the true Geographical Longitude of the Magellan Straights. By the same.*

- I. *An Account of the Rain which fell every Year at Upminster in Essex, the last Eighteen Years, with Remarks upon that of the Year 1714.* By W. Derham, F. R. S. *Also a Comparison of what has been observed of that kind at Paris, by M. De la Hire.*

**I** A S T Year having been so remarkably Dry, that Ponds hereabouts are for the most part dry, and the Springs generally either very low or quite failing, I had the Curiosity to make an Extract (out of my Registers of the Weather, &c.) of the *Quantity of Rain* which fell at *Upminster* the last 18 Years. The Particulars of which, every Year, may be seen in the following Table. In one Column of which, the Weight of the Rain in Pounds *Troy* and Centesimals of Pounds, may be seen; in the other, the Depth of it in Inches and Centesimals of Inches, or what Height it would have been, had it not been imbibed by the Earth, or lessened by Exhalations, but been suffered to have stagnated on the Ground.

Among the *Dry Years*, 1704 was complained of for one; which I remember the News-Papers reported to have been so considerable at *Venice*, that they were forced to fetch their Water in Barks five Leagues off, as far as the *Brenta*; so that publick Prayers were put up for Rain. Yet we may observe that several other Years were drier than that with us at *Upminster*. But among them all, none comparable to the last Year 1714. In which the whole Quantity of Rain was no more than 55 l 95 Hundredths, or 11 Inches 19 Hundredths; whereas the least Quantity of any of the preceding 18 Years, exceeded 15 Inches in Depth.

What Effects this Drought hath had in the Bodies of Animals, I leave others to judge. It is well known how contagious and fatal a Distemper hath raged among, not only

only our own Black Cattle, but in many other Parts of *Europe*. And I observed the *Itch* was epidemical among the poorer sort, at the beginning of the Year; that the *Measles* were very common, some Parts of the Year; and that *Pleurisies* and *Malignant Feavers* infested a great many, especially in the Summer Months. But how far these Distempers might be owing to the Dry Season, I leave to the Judgment of our learned Physicians.

With greatest Duty and Respect I am the Society's

*Most humble Servant, &c.*

A TABLE of Rain which fell  
at *Upminster*, from the Year  
1697, to the Year 1714.

Year	Weight.		Depth.	
	l.	Cent.	inch.	Cent.
1697	77	60	15	52
1698	122	32	24	46
1699	75	54	15	11
1700	95	13	19	03
1701	93	45	18	69
1702	101	89	20	38
1703	119	94	23	99
1704	79	02	15	81
1705	84	62	16	93
1706	121	43	24	29
1707	81	55	16	31
1708	96	09	19	22
1709	132	82	26	56
1710	91	84	18	37
1711	118	02	23	60
1712	118	78	23	76
1713	115	80	23	16
1714	55	95	11	19

To compare with these, we have collected out of the *Memoirs* of the *Royal Academy* of *Sciences*, the Quantity of *Rain* and *Dissolved Snow* which has fallen at the *Observatory* at *Paris* for 23 Years together ; according to the accurate *Observation* of *M. De la Hire*. And that the *Comparison* might be made more justly, we have reduced the *French Measure* to our own. But it is to be observed that the *Diversity* of *Stile* makes the *Years* not exactly the same, though, as to this *Matter*, the difference may seem very *inconsiderable*. We have forborn to make any *Remarks* upon this *Comparison*, leaving it to the *Consideration* of the curious *Reader*.

Anno.	French		English	
	Inch	lin.	inch.	Cent.
1689	18	11 $\frac{1}{2}$	20	23
1690	23	3 $\frac{3}{4}$	24	87
1691	14	5 $\frac{1}{4}$	15	40
1692	22	7 $\frac{1}{2}$	24	14
1693	22	8	24	18
1694	19	9	21	07
1695	19	7 $\frac{3}{4}$	20	96
1696	19	5 $\frac{1}{2}$	20	76
1697	20	3	21	60
1698	21	9	23	20
1699	18	8 $\frac{1}{4}$	19	93
1700	20	0 $\frac{1}{2}$	21	38
1701	21	4 $\frac{1}{4}$	22	78
1702	16	4	17	42
1703	17	4 $\frac{1}{2}$	18	51
1704	19	10 $\frac{1}{2}$	21	20
1705	13	10 $\frac{1}{4}$	14	82
1706	15	3 $\frac{3}{8}$	16	32
1707	17	11	19	11
1708	18	3 $\frac{1}{2}$	19	51
1709	21	9 $\frac{1}{2}$	23	21
1710	15	8 $\frac{3}{4}$	17	10
1711	25	2	26	84

II. *Solutio Generalis Problematis XV. propositi à D. de Moivre, in tractatu de Mensura Sortis inserto Actis Philosophicis Anglicanis No 329. pro numero quocunque Collusorum: per D. Nicolaum Bernoulli, Basiliensem, Reg. Soc. Sodalem.*

CUM Methodus synthetica, quâ usus est *D. de Moivre* ad inveniendam cujusque Collusoris sortem, in usum verti nequeat tunc quando plures quam tres sunt collusores, ob vix perspiciendam legem progressionis serierum quæ se offerunt; ostendam hic quo modo Analysis in ejusmodi Problematis, ubi depositum continuo augetur, adhiberi queat: eumque in finem demonstrationem dabo analyticam trium Theorematum, quæ inveni, & quidem diu ante visum *D. Moivre* libellum de Mensura Sortis, occasione triplicis quæstionis mihi ab amico circa ludum hunc, quem Galli vocant *le Jeu de la Poule*, propositæ, pro inveniendis scil. probabilitate vincendi, lucro item vel damno cujusque Collusoris, & duratione certaminis.

### THEOREMA I.

Si Collusores aliquot *A, B, C, D, E, &c.* quorum numerus est  $n+1$  & dexteritates sunt æquales, deponant singuli 1, & istis conditionibus certent. 1°. Ut illorum duo *A & B* ludum incipiant. 2°. Ut victus locum suum tertio *C* cedat, ita ut ille tertius *C* jam cum victore contendat, quique ex hoc certamine victor evaserit cum quarto *D* ludat, & ita deinceps. 3°. Ut ille depositum totum obtineat, qui omnes collusores successivè vicerit. Dico probabilitates vincendi duorum quorumlibet collusorum sese immediate in ordine ludendi sequentium esse in ratione  $1 + 2^n$  ad  $2^n$ , adeoque expectationes lusorum *A (B), C, D, E, &c.* esse in progressionem Geometricam.

*Demonstratio.*

Ponantur expectationes vincendi ipsius *A* vel  $B = a$ , ipsius  $C = c$ , ipsius  $D = d$ , ipsius  $E = e$ , &c. Porro cum accidere possit, ut collusor aliquis prima vice in ludum intrans inveniatur adversarium qui vel nondum, vel semel, vel bis, vel ter, &c. jam successive victor extitit, vocetur expectatio lusoris illius primo casu  $= z$ , secundo  $= y$ , tertio  $= x$ , quarto  $= u$ , quinto  $= t$ , &c. Item cum collusor aliquis vinci possit ab adversario qui antea jam vel nullum, vel unum, vel duos, vel tres, &c. collusores successive vicit, ita ut exiens è ludo relinquatur adversarium qui vel semel, vel bis, vel ter, vel quater &c. victor extitit, vocetur expectatio seu probabilitas vincendi ejus qui exit è ludo primo casu  $= b$ , secundo  $= k$ , tertio  $= l$ , quarto  $= m$ , &c. Hisce omnibus positis habebuntur sequentes novem series æquationum signatæ N°. 1. N°. 2. N°. 3, &c. usque ad N°. 9. *Tab. I.* Ratio eas inveniendi breviter hæc est.

Inter æquationes N. 1°. reperitur *ex. gr.*  $f = \frac{1}{8}t + \frac{1}{8}u + \frac{1}{4}x$

$+ \frac{1}{2}y$ . Nam collusor *F* certabit vel cum collusore *A*, vel *B*,

vel *C*, vel *D*, vel *E* : ut primum vel secundum contingat, oportet ut vel *A* vel *B* quater successive victor existat, cujus even-

tus probabilitas est  $\frac{2}{16}$  seu  $\frac{1}{8}$  : Ut tertium contingat oportet ut *C* ter victor existat, cujus eventus probabilitas est eti-

am  $\frac{1}{8}$  : Ut quartum contingat oportet ut *D* bis successive vin-

cat, quod probabilitatem habet  $\frac{1}{4}$  ; Ut quintum contingat,

oportet ut *E* semel vincat, cujus eventus probabilitas est  $\frac{1}{2}$  ;

ergo

ergo lusoris  $F$  probabilitas vincendi est  $= \frac{1}{8} l + \frac{1}{8} * + \frac{1}{4} x$   
 $+ \frac{1}{2} \gamma$ . Sic inter æquationes No. 2. est, *ex. gr.*  $x = \frac{1}{2} l$

$+ \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots + \frac{1}{2^n} \times b + \frac{1}{2^n} \times 1$ . Collusor enim  
 qui certat cum adversario qui jam bis successive victor exitit,  
 vincere potest vel omnes collusores, vel aliquos, vel nullum.

Prioris eventus probabilitas est  $\frac{1}{2^n}$ , secundi  $\frac{1}{4} + \frac{1}{8} + \frac{1}{16} +$   
 $\dots + \frac{1}{2^n}$ , & tertii  $\frac{1}{2}$ ; si primus eventus contingat, probabilitas

vincendi evadit certitudo integra seu 1; si secundus, exit è lu-  
 do relinquens collusorem qui semel vicit; si tertius, exit è  
 ludo relinquens collusorem qui ter successive vicit; adeoque

fors ejus totalis est  $\frac{1}{2} \times l + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} \dots + \frac{1}{2^n} \times b + \frac{1}{2^n} \times 1$ .

Simili ratiocinio inveniuntur æquationes N°. 3. Collu-  
 sor enim qui victus ab adversario exit è ludo, relinquens *ex.gr.*  
 collusorem unius tantum ludi victorem, acquirit sortem vel  
 ipsius  $C$ , vel ipsius  $D$ , vel ipsius  $E$ , vel ipsius  $F$ , &c. prout  
 adversarius à quo victus est vincit vel omnes collusores præter  
 unum, vel omnes præter duos, vel omnes præter tres, &c.

unde sequitur quod  $b = \frac{1}{2^{n-1}} \times c + \frac{1}{2^{n-2}} \times d + \frac{1}{2^{n-3}} \times e + \frac{1}{2^{n-4}}$

$\times f + \&c.$  Æquationes N°. 4. inveniuntur subtrahendo æqua-  
 tiones N°. 2. ab invicem: & æquationes N°. 5. subtrahendo  
 æquationes N°. 3. ab invicem. Æquationes N°. 6. inveni-  
 untur substituendo in æquationibus N°. 4. valores inventos  
 per æquationes N°. 5. Æquationes N°. 7. inveniuntur quæ-  
 rendo valores ipsarum  $z, y, x, u$ , &c. per æquationes N°. 1.  
 Et his valoribus substitutis in æquationibus N°. 4. habebuntur  
 æquationes No. 8, quæ comparatæ cum æquationibus N°. 6.

dant æquationes N<sup>o</sup>. 9. ex quibus sequitur quod  $1 + 2^n : 2^n :: a : c :: c : d :: d : e$ , &c. *Q. E. D.*

*Corollarium.*

Hinc faciliè inveniuntur probabilitates vincendi singulorum Collusorum, quas habent tum ante ludum inceptum, tum in quolibet statu in quem ludum prosequendo pervenire possunt. Si sint, *ex gr.* tres collusores *A, B, C*, erit  $n = 2$ , &  $1 + 2^n : 2^n :: 5 : 4 :: a : c$  : id est, probabilitates vincendi ipsorum *A, B, C*, antequam *A* vicerit *B*, vel *B* vicerit *A*, se habent ut numeri

5, 5, 4, adeoque ipsæ probabilitates sunt  $\frac{5}{14}, \frac{5}{14}, \frac{4}{14}$  : omnes enim simul sumptæ facere debent 1 seu certitudinem integram.

Postquam *A* vicerit *B*, probabilitates vincendi ipsorum *B, C, A*, erunt *b, y* seu *c*, & (quia *A* æqualem habet expectationem ad victoriam, & ad sortem ipsius *B* obtinendam)  $\frac{1+b}{2}$  respectivè,

*hoc est*, quia per æq. 1. N<sup>o</sup>. 3.  $b = \frac{1}{2^{n-1}} \times c = \frac{1}{2} c$ , &  $c = \frac{4}{14} =$

$\frac{2}{7}$  ut modo inventum, hæc probabilitates erunt  $\frac{1}{7}, \frac{2}{7}, \frac{4}{7}$ , ut

*D. de Moivre* invenit Coroll. 1. Prop. 15. pag. 242.

Si sint quatuor collusores *A, B, C, D*, erit  $n = 3$ , &  $1 + 2^n : 2^n :: 9 : 8$ , adeoque probabilitates collusorum ab initio ludi erunt ut 9, 9, 8,  $\frac{8 \times 8}{9}$ , sive ut 81, 81, 72, 64, *hoc est*, ipsæ *a, a,*

*c, d*, erunt  $\frac{81}{298}, \frac{81}{298}, \frac{72}{298}$  &  $\frac{64}{298}$ . Postquam *A* vicerit *B*, pro-

babilitates ipsorum *B, D, C, A*, erunt *b, d, c*,  $\frac{1+3b}{4}$ , est au-

tem per æq. 1. N<sup>o</sup>. 3.  $b = \frac{1}{2^{n-1}} \times c + \frac{1}{2^{n-2}} \times d = \frac{1}{4} c + \frac{1}{2} d$ ,



$\bar{e} = \frac{72}{298} = \frac{36}{149}$ , &  $d = \frac{64}{298} = \frac{32}{149}$ , ut modo inventum :

ergo hæ probabilitates erunt  $\frac{25}{149}$ ,  $\frac{32}{149}$ ,  $\frac{36}{149}$ ,  $\frac{56}{149}$  respective.

Postquam  $A$  vicerit  $B$  &  $C$ , probabilitates vincendi ipsorum  $C, B, D, A$ , erunt  $k, \frac{c}{2}, x, \frac{1+b}{2}$ , seu (quia per æq. 2. N°. 3.

$k = \frac{1}{2^{n+2}} \times d = \frac{1}{2} d$ , & per æq. 3. N°. 7.  $x = 2d - c$ )  $\frac{16}{149}, \frac{18}{149}, \frac{28}{149}, \frac{87}{149}$ . Et nota quod calculi bonitas confirmetur ex eo,

quod summæ harum probabilitatum, *hoc est*,  $\frac{1}{7} + \frac{2}{7} + \frac{4}{7}$  in

priori exemplo, &  $\frac{25}{149} + \frac{32}{149} + \frac{36}{149} + \frac{56}{149}$ , nec non  $\frac{16}{149} + \frac{18}{149} + \frac{28}{149} + \frac{87}{149}$  in posteriori exemplo, singulæ sint = 1 seu certitudini integræ.

## THEOREMA II.

Positis quæ prius & insuper hac conditione, ut victus semper mulctetur summa  $p$ , quæ deposito augendo inserviat ; quod depositum sic gradatim auctum illi soli cedat, qui omnium successive collusorum victor extiterit ; denotatis etiam ut antea per literas minúsculas  $a, c, d, e$ , &c. probabilitatibus vincendi ipsorum  $A$  (vel  $B$ ),  $C, D, E$ , &c. respective : per easdem vero literas majúsculas  $A, C, D, E$ , &c. ipsorum  $A$  (vel  $B$ ),  $C, D, E$ , &c. expectationibus, *hoc est*, portíonibus depositi

quas singuli expectant : Dico, fore semper  $C = \frac{A + ap \times 2^n - ncp}{1 + 2^n}$

X

D=

$$D = \frac{C + c p \times 2^n - n d p}{1 + 2^n}, E = \frac{D + d p \times 2^n - n e p}{1 + 2^n}, \&c.$$

*Demonstratio.*

Denotetur ut prius per literas minuscultas *z, y, x, u, t, &c.* probabilitas vincendi ludentis cum adversario, qui jam vel nullum, vel unum, vel duos, &c. collusores successive vicit; per easdem vero literas majusculas *Z, Y, X, U, T, &c.* ejus expectatio, quam scilicet habet diversis illis casibus, deposito existente  $n + 1, n + 1 + p, n + 1 + 2p, n + 1 + 3p, \&c.$  respectivè. Sic etiam per literas minuscultas *h, k, l, m, &c.* denotetur probabilitas vincendi lusoris victi ab adversario, qui antea vel nullum, vel unum, vel duos, &c. collusores successive vicerat; quemadmodum per literas majusculas *H, K, L, M, &c.* ejusdem expectatio diversis illis casibus, deposito existente  $n + 1 + p, n + 1 + 2p, n + 1 + 3p, \&c.$  respectiva. His positis iisdem quibus antea ratiociniis inveniuntur sequentes duodecim æquationum series in *Tab. II.* signatæ N°. 1. N°. 2. N°. 3, &c. Inter

$$\text{æquationes N°. 1. ex. gr. est } E = \frac{U}{4} + \frac{X + xp}{4} + \frac{T + 2yp}{2}.$$

Lusor enim *E* ludet vel cum lusore *A*, vel lusore *B*, vel *C*, vel *D*. Si ludit cum *A* vel *B*, expectatio ejus erit  $= U$ , quia ludit cum adversario qui jam tres adversarios vicit, deposito existente  $n + 1 + 3p$ . Si ludit cum lusore *C*, expectatio ejus erit  $= X + xp$ , ludit enim cum adversario qui jam duos collusores vicit, adeoque si depositum esset  $n + 1 + 2p$  ejus expectatio esset  $= X$ : verum quia ludente *E* depositum est  $= n + 1 + 3p$ , ob tres collusores victos & summa *p* multatos, addenda est expectationi *X* portio illa multæ unius *p*, quam lusor *E* sperare potest: est autem hæc portio (quia probabilitas ejus vincendi est  $x$ )  $= xp$ , ejus igitur expectatio totalis tunc erit  $= X + xp$ . Sic si ludit cum lusore *D*, expectatio ejus erit  $= T + 2yp$ : additur ad *T* (quæ esset ejus expectatio deposito existente  $n + 1 + p$ ) portio  $2yp$ , quæ ipsi debetur de duabus multis

multis  $2p$ , quibus depositum  $n + 1 + 3p$  majus est quam  $n + 1 + p$ . Simili modo habentur æquationes N<sup>o</sup>. 2. 3. 4. & 5. Substituendo autem primam æquationem N<sup>o</sup>. 2. *Tab. I.* in æquationibus N<sup>o</sup>. 4. habentur æquationes N<sup>o</sup>. 6. Et substituendo primam æquationem N<sup>o</sup>. 3. *Tab. I.* in æquationibus N<sup>o</sup>. 5. habentur æquationes N<sup>o</sup>. 7. quibus dein in æquationibus No 6. substitutis habentur æquationes No. 8. Æquationes N<sup>o</sup> 9. inveniuntur quærendo valores ipsarum  $Z, Y, X, U$ , &c per æquationes N<sup>o</sup>. 1. *Tab. I.* & II. vel N<sup>o</sup> 2. *Tab. II.* & N<sup>o</sup>. 7. *Tab. I.* Et his valoribus substitutis in æquationibus N<sup>o</sup>. 4. habentur æquationes N<sup>o</sup>. 10. Quæ comparatæ cum æquationibus N<sup>o</sup>. 8 (in quibus pro  $z$  substituatur  $a$ , per 1. æq. *Tab. I.*) dant æquationes N<sup>o</sup>. 11. Et hæ æquationes N<sup>o</sup>. 11. comparatæ cum æquationibus N<sup>o</sup>. 9. *Tab. I.* dant æquationes N<sup>o</sup>. 12, quæ constituunt Theorema, quod demonstrandum erat.

*Corollarium.*

Hinc quoque facile inveniuntur singulorum Collusorum sortes seu expectationes, ipforumque adeo lucra vel damna.

Sint *ex. gr.* tres collusores  $A, B, C$ : erit  $C = \frac{A + ap \times 2^n - nc p}{1 + 2^n}$

$$= (\text{ob } n = 2) \frac{4A + 4ap - 2cp}{5} = (\text{ob } a = \frac{5}{14} \text{ \& } c = \frac{2}{7})$$

per coroll. Theor. 1.)  $\frac{4A + \frac{6}{5}p}{5}$ . Unde cum omnium trium

expectationes simul sumptæ, *id est*,  $A + A + C$  æquare debeant id quod ab initio depositum fuit, *id est* 3, erit  $2A + \frac{4A + \frac{6}{5}p}{5} = \frac{14A + \frac{6}{5}p}{5} = 3$ , &  $14A = 15 - \frac{6}{5}p$ , &

$$A = \frac{15}{14} - \frac{3}{49}p = \text{expectationi lusoris } A \text{ vel } B: \text{ proinde } C$$

$$\text{expectatio lusoris tertii } C = \frac{4A + \frac{6}{5}p}{5} = \frac{6}{7} + \frac{6}{49}p. \text{ A qui-}$$

X 2

bus

bus expectationibus si subtrahatur 1, id quod ab initio singuli deposuerunt, remanebit ibi  $\frac{1}{14} - \frac{3}{49} p$ , hic  $\frac{6}{49} p - \frac{1}{7}$ ; quemadmodum D. de Moivre invenit. Exempl. 2. Sint collutores 4, A, B, C, D, erit  $C = \frac{A + ap \times 2^n - ncp}{1 + 2^n} = (\text{ob } n=3)$

$$\frac{8A + 8ap - 3cp}{9} = (\text{ob } a = \frac{81}{298} \& c = \frac{36}{149}, \text{ per coroll.})$$

$$\text{Theor. 1.) } \frac{8A + \frac{216}{149}p}{9}; \text{ item } D = \frac{C + cp \times 2^n - ndp}{1 + 2^n} =$$

$$\frac{8C + 8cp - 3dp}{9} = (\text{ob } d = \frac{32}{149} \text{ per id. corr.}) \frac{8C + \frac{102}{149}p}{9} =$$

$$\frac{64A + \frac{3456}{149}p}{81}; \text{ unde habebitur æquatio } 2A + C + D = 2A +$$

$$\frac{8A + \frac{216}{149}p}{9} + \frac{64A + \frac{3456}{149}p}{9} = \frac{298A + \frac{3600}{149}p}{81} = 4, \text{ sive } 149A$$

$$+ \frac{2700}{149}p = 162, \& A = \frac{162}{149} - \frac{2700}{22201}p. \text{ Hinc } C =$$

$$\frac{8A + \frac{216}{149}p}{9} = \frac{144}{149} + \frac{1176}{22201}p, \& D = \frac{64A + \frac{3456}{149}p}{81} = \frac{128}{149}$$

$$+ \frac{4224}{22201}p. \text{ Subtracta autem unitate 1, quam singuli ab ini-$$

$$\text{tio ludi deposuerunt, remanebit } \frac{13}{149} - \frac{2700}{22201}p \text{ pro lusore}$$

$$A \text{ vel } B, \frac{1176}{22201}p - \frac{5}{149} \text{ pro } C, \& \frac{4224}{22201}p - \frac{21}{149} \text{ pro } D;$$

quæ singula indigitabunt lucrum vel damnum, prout pars affirmata præpollet negatæ, vel contra. Simili ratione habebuntur etiam sortes quas acquirunt in quolibet statu in quem ludum prosequendo pervenire possunt.

## THEOREMA 3.

Positis quæ prius, si adsint spectatores  $\mathcal{Q}, R, S, T, U$ , &c. quorum numerus sit  $n$  unitate minor quam numerus collusorum, quorumque prior  $\mathcal{Q}$  affirmer certamen finitum iri post  $n+p$  ludos peractos,  $R$  post  $n+p-1$ ,  $S$  post  $n+p-2$ ,  $T$  post  $n+p-3$ ,  $U$  post  $n+p-4$ , &c. præcise, non antea; sintque  $q, r, s, t, u$ , &c. fortes ipsorum  $\mathcal{Q}, R, S, T, U$ , &c. Dico fore  $q = \frac{1}{2} r + \frac{1}{4} s + \frac{1}{8} t + \frac{1}{16} u + \&c.$

*Demonstratio.*

Vocetur  $A$  collusor ille, qui post  $n+p$  ludos vincere supponitur: hic intrare debet in ludum post  $p$  ludos peractos, & tum ludet contra adversarium, qui jam vel unum vel duos, vel tres, &c. collusores successive vicit. Jam cum, ut primus casus contingat, & ut collusor  $A$  omnes suos collusores præter unum, *id est*,  $n-1$  collusores successive vincat, æque probabile sit quam ut adversarius ejus vincat  $n-1$  collusores, *id est*, (quia jam unius collusoris victor fuit) ut certamen finiat post  $n+p-1$  ludos peractos; hujusque eventus probabilitas sit  $= r$ : erit probabilitas ut collusor  $A$  unum adhuc collusorem vincat, *id est*, certamen finiat post  $n+p$  ludos  $= \frac{1}{2} r$ . Sic, ut secundus; casus existat, & ut  $A$  omnes collusores præter duos vincat, æque probabile est quam ut certamen finiatur post  $n+p-2$  ludos, adeoque ut tunc  $A$  vincat adhuc duos collusores, *id est*, ut certamen finiat post  $n+p$  ludos, probabilitas erit  $= \frac{1}{4} s$ . Eodem modo ut, tertio casu existente,  $A$  vincat omnes collusores, probabilitas est  $= \frac{1}{8} t$ ; ut quarto  $= \frac{1}{16} u$ , &c. Quare ut

Y indiffe-

indifferenter certamen finiatur post  $n + p$  ludos, probabilitas est

$$\frac{1}{2}r + \frac{1}{4}s + \frac{1}{8}t + \frac{1}{16}u + \&c. = q. \quad \text{Q. E. D.}$$

*Corollarium 1.*

Facile hinc invenitur quænam sit probabilitas ut certamen finiatur intra datum quemvis ludorum numerum. Series enim

fractionum incipientium à fractione  $\frac{1}{2^{n-1}}$ , quarum denomina-

tores crescant in continua proportionem dupla, numerator autem cujusque fractionis sit summa numeratorum tot fractionum immediate præcedentium quot sunt unitates in  $n-1$ , dabit omnes successive probabilitates, ut certamen finiatur peractis præcise  $n, n+1, n+2, n+3$  &c. ludis: & per consequens si addantur tot termini hujus seriei quot sunt unitates in  $p+1$ , summa ipsorum exprimet probabilitatem ut certamen finiatur ad minimum ludis  $n+p$  peractis. *Ex. gr.* Si sint collusores 4,

adeoque  $n=3$ , habebitur hæc series  $\frac{1}{4}, \frac{1}{8}, \frac{2}{16}, \frac{3}{32}, \frac{5}{64}, \frac{8}{128}$

$\frac{13}{256}, \frac{21}{512}$  &c. E qua si fiat alia  $\frac{1}{4}, \frac{3}{8}, \frac{8}{16}, \frac{19}{32}, \frac{43}{64}, \frac{94}{128}, \frac{201}{256}$ ,

&c. cujus termini sint summæ terminorum præcedentis seriei, denotabunt iidem termini qualis sit probabilitas ut certamen finiatur ad minimum 3, 4, 5, 6, &c. ludis.

*Corollarium 2.*

Potest terminus quicunque prioris seriei (excepto primo termino,) ut & summa omnium terminorum, *id est*, terminus quicunque posterioris seriei, per formulam generalem exprimi hoc modo. Si  $n+1$  sit numerus collusorum, &  $p$  sit numerus terminorum, erit ultimus terminus prioris seriei

$$\frac{1}{2^n}$$

$$\frac{1}{2^n} - \frac{p-n+1}{1 \times 2^{2n}} + \frac{p-2n \times p-2n+3}{1 \times 2 \times 2^{3n}} -$$

$$\frac{p-3n \times p-3n+1 \times p-3n+5}{1 \times 2 \times 3 \times 2^{4n}} +$$

$$+ \frac{p-4n \times p-4n+1 \times p-4n+2 \times p-4n+7}{1 \times 2 \times 3 \times 4 \times 2^{5n}}, -\&c. \text{ Et}$$

summa omnium terminorum five ultimus terminus posterioris

seriei =  $\frac{p+1}{1 \times 2^n} - \frac{p-n \times p-n+3}{1 \times 2 \times 2^{2n}} + \frac{p-2n \times p-2n+1 \times p-2n+5}{1 \times 2 \times 3 \times 2^{3n}}$

$$- \frac{p-3n \times p-3n+1 \times p-3n+2 \times p-3n+7}{1 \times 2 \times 3 \times 4 \times 2^{4n}} + \&c.$$

Tabula I.

Intrat		Exit.		N <sup>o</sup> . 1	
Sors		Sors			
0	z	1	b	a = z	
1	y	2	k	c = y	
2	x	3	l	d = $\frac{1}{2}x + \frac{1}{2}y$	
3	u	4	m	e = $\frac{1}{4}u + \frac{1}{4}x + \frac{1}{2}y$	
4	t			f = $\frac{1}{8}t + \frac{1}{8}u + \frac{1}{4}x + \frac{1}{2}y$	

N<sup>o</sup>. 2.

$$z = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots - \frac{1}{2^n} \times b + \frac{1}{2^n} \times 1$$

$$y = \frac{1}{2}k + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots - \frac{1}{2^n} \times b + \frac{1}{2^n} \times 1.$$

$$x = \frac{1}{2}l + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots - \frac{1}{2^n} \times b + \frac{1}{2^n} \times 1.$$

$$u = \frac{1}{2}m + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots - \frac{1}{2^n} \times b + \frac{1}{2^n} \times 1$$

No. 3.

N<sup>o</sup>. 3.

$$b = \frac{1}{2^{n-1}} \times c + \frac{1}{2^{n-2}} \times d + \frac{1}{2^{n-3}} \times e + \frac{1}{2^{n-4}} \times f + \dots$$

$$k = \frac{1}{2^{n-2}} \times d + \frac{1}{2^{n-3}} \times e + \frac{1}{2^{n-4}} \times f + \dots$$

$$l = \frac{1}{2^{n-3}} \times e + \frac{1}{2^{n-4}} \times f + \dots$$

$$m = \frac{1}{2^{n-4}} \times f + \dots$$

N<sup>o</sup>. 4.N<sup>o</sup>. 6.N<sup>o</sup>. 8.

$$z - y = \frac{1}{2} b - \frac{1}{2} k = \frac{1}{2^n} \times c = a - c$$

$$y - x = \frac{1}{2} k - \frac{1}{2} l = \frac{1}{2^{n-1}} \times d = 2c - 2d$$

$$x - u = \frac{1}{2} l - \frac{1}{2} m = \frac{1}{2^{n-2}} \times e = 4d - 4e$$

N<sup>o</sup>. 5.N<sup>o</sup>. 7.N<sup>o</sup>. 9.

$$\begin{array}{l} b - k = \frac{1}{2^{n-1}} \times c \\ k - l = \frac{1}{2^{n-2}} \times d \\ l - m = \frac{1}{2^{n-3}} \times e \end{array} \left| \begin{array}{l} z = a \\ y = c \\ x = 2d - y = 2d - c \\ u = 4e - x - 2y = 4e - 2d - c \end{array} \right. \begin{array}{l} c = a \times \frac{2^n}{1 + 2^n} \\ d = c \times \frac{2^n}{1 + 2^n} \\ e = d \times \frac{2^n}{1 + 2^n} \end{array}$$

*Corollarium 3.*

Potest quis priusquam ludus inchoetur in se suscipere, ut summam  $n + 1$  de qua collusores contendunt, & multas omnes pendat, si sibi initio in manus datum sit  $n + 1 + 2^{n-1} \times p$ .

Demonstrationem duorum præcedentium corollariorum curiosis indagandam relinquo.



III. *Solutio generalis altera præcedentis Problematis, ope Combinatorum & Serierum infinitarum, per D. Abr. de Moivre. Reg. Soc. Sodalem.*

*Designationes.*

**S**I  $B$  &  $C$  collusores duo simul certent, ad designandum  $B$  victorem esse,  $C$  victum, scribatur  $BC$ ; atque vicissim ad designandum  $C$  victorem esse,  $B$  victum; scribatur  $CB$ : & sic de cæteris.

Ponatur 1°  $B$  vincere  $A$ , certamenque concludi tribus ludis

$$\left. \begin{array}{l} BA \\ \hline BC \\ BD \end{array} \right\} \text{Sic patet } B \text{ victorem necessario evadere.}$$

Ponatur 2°  $B$  vincere  $A$ , certamenque concludi quatuor ludis

$$\left. \begin{array}{l} BA \\ \hline CB \\ CD \\ CA \end{array} \right\} \text{Sic patet } C \text{ victorem necessario evadere.}$$

Ponatur 3°  $B$  vincere  $A$ , certamenque concludi quinque ludis

$$\left. \begin{array}{ll} BA & BA \\ \hline CB^* & BC \\ DC & DB \\ DA & DA \\ DB & DC \end{array} \right\} \text{Sic patet } D \text{ victorem necessario evadere, id-} \\ \text{que duplici modo.}$$

Ponatur 4°  $B$  prima vice vincere  $A$ , certamenque concludi sex ludis.

$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	} Sic patet $A$ victorem necessario evadere, idque triplici modo.
$\overline{CB}$	$\overline{CB^*}$	$\overline{BC}$	
$\overline{DC^*}$	$\overline{CD^*}$	$\overline{DB}$	
$\overline{AD}$	$\overline{AC}$	$\overline{AC}$	
$\overline{AB}$	$\overline{AB}$	$\overline{AD}$	
$\overline{AC}$	$\overline{AD}$	$\overline{AB}$	

Ponatur 5° certamen concludi septem ludis, ponaturque semper  $B$  prima vice vincere ipsum  $A$ .

$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	} Sic patet $B$ vel $C$ necessario victores evadere, $B$ triplici modo, $C$ duplici.
$\overline{CB}$	$\overline{CB}$	$\overline{CB^*}$	$\overline{BC}$	$\overline{BC}$	
$\overline{DC}$	$\overline{DC^*}$	$\overline{CD}$	$\overline{DB}$	$\overline{DB}$	
$\overline{AD^*}$	$\overline{DA}$	$\overline{AC}$	$\overline{AD^*}$	$\overline{DA}$	
$\overline{BA}$	$\overline{BD}$	$\overline{BA}$	$\overline{CA}$	$\overline{CD}$	
$\overline{BC}$	$\overline{BC}$	$\overline{BD}$	$\overline{CB}$	$\overline{CB}$	
$\overline{BD}$	$\overline{BA}$	$\overline{BC}$	$\overline{CD}$	$\overline{CA}$	

Ponatur 6° certamen concludi octo ludis,

$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$
$\overline{CB}$	$\overline{CB}$	$\overline{CB}$	$\overline{CB}$	$\overline{CB^*}$	$\overline{BC}$	$\overline{BC}$	$\overline{BC}$
$\overline{DC}$	$\overline{DC}$	$\overline{DC^*}$	$\overline{CD}$	$\overline{CD}$	$\overline{DB}$	$\overline{DB}$	$\overline{DB}$
$\overline{AD}$	$\overline{AD^*}$	$\overline{DA}$	$\overline{AC}$	$\overline{AC}$	$\overline{AD}$	$\overline{AD^*}$	$\overline{DA}$
$\overline{BA^*}$	$\overline{AB}$	$\overline{BD}$	$\overline{BA^*}$	$\overline{AB}$	$\overline{CA^*}$	$\overline{AC}$	$\overline{CD}$
$\overline{CB}$	$\overline{CA}$	$\overline{CB}$	$\overline{DB}$	$\overline{DA}$	$\overline{BC}$	$\overline{BA}$	$\overline{BC}$
$\overline{CD}$	$\overline{CD}$	$\overline{CA}$	$\overline{DC}$	$\overline{DB}$	$\overline{BD}$	$\overline{BD}$	$\overline{BA}$
$\overline{CA}$	$\overline{CB}$	$\overline{CD}$	$\overline{DA}$	$\overline{DC}$	$\overline{BA}$	$\overline{BC}$	$\overline{BD}$

Sic patet  $C$  victorem evadere triplici,  $D$  duplici,  $B$  triplici modo, &c.

Nunc ordine scribantur literæ quibus victores designantur.

3,	1 $B$
4,	1 $C$
5,	2 $D$
6,	3 $A$
7,	3 $B$ + 2 $C$
8,	3 $C$ + 2 $D$ + 3 $B$ .
9,	3 $D$ + 2 $A$ + 3 $C$ + 3 $D$ + 2 $A$
10,	3 $A$ + 2 $B$ + 3 $D$ 3 $A$ + 2 $B$ + 3 $A$ + 2 $C$ + 3 $D$

&c. Per.

Perſpecta illarum formatione, patebit 1° literam *B* in ordine aliquo ſemper toties reperiri, quoties *A* in ordine ultimo & penultimo reperitur : 2° *C* in ordine aliquo toties reperiri quoties *B* in ordine ultimo & *D* in penultimo reperiuntur : 3° *D* in ordine aliquo toties reperiri quoties *C* in ultimo & *B* in penultimo : 4° *A* in ordine aliquo ſemper toties reperiri quoties *D* in ordine ultimo & *C* in penultimo reperiuntur.

Sed numerus variationum dato cuilibet ludorum numero competens, duplus eſt numeri variationum omnium dato ludorum numero unitate diminuto competentis : adeoque Probabilitas quam habet Colluſor *B* ut vincat dato ludorum numero, eſt ſubdupla probabilitatis quam habebat *A* ut vinceret dato ludorum numero minus uno ; atque etiam ſubquadrupla probabilitatis quam habebat idem *A*, ut vinceret dato ludorum numero minus duobus : & ſic de cæteris.

Probabilitas quam habet *C*, ut vincat dato ludorum numero, eſt ſubdupla probabilitatis quam habebat *B*, ut vinceret dato ludorum numero minus uno ; atque etiam ſubquadrupla probabilitatis quam habebat *D*, ut vinceret dato ludorum numero minus duobus.

Probabilitas quam habet *D* ut vincat dato ludorum numero, eſt ſubdupla probabilitatis quam habebat *C*, ut vinceret dato ludorum numero minus uno ; atque etiam ſubquadrupla probabilitatis quam habebat *B*, ut vinceret dato ludorum numero minus duobus.

Probabilitas quam habet *A* ut vincat dato ludorum numero, eſt ſubdupla probabilitatis quam habebat *D*, ut vinceret dato ludorum numero minus uno ; atque etiam ſubquadrupla probabilitatis quam habebat *C* ut vinceret dato ludorum numero minus duobus.

Ex jam obſervatis facile eſt componere Tabulam Probabilitatum, quas *B*, *C*, *D*, *A* habent ut victores evadant dato ludorum numero, atque etiam illorum fortium ſeu expectationum :

## Tabula Probabilitatum, &amp;c.

	B	C	D	A
'	$3 \frac{1}{4} \times 4 + 3p$	—	—	—
"	4	$\frac{1}{8} \times 4 + 4p$	—	—
'''	5	—	$\frac{2}{16} \times 4 + 5p$	—
'''	6	—	—	$\frac{3}{32} \times 4 + 6p$
v	$7 \frac{3}{64} \times 4 + 7p$	$\frac{2}{64} \times 4 + 7p$	—	—
v'	$8 \frac{3}{128} \times 4 + 8p$	$\frac{3}{128} \times 4 + 8p$	$\frac{2}{128} \times 4 + 8p$	—
v''	9	$\frac{3}{256} \times 4 + 9p$	$\frac{6}{256} \times 4 + 9p$	$\frac{4}{256} \times 4 + 9p$
v'''	$10 \frac{4}{512} \times 4 + 10p$	$\frac{2}{512} \times 4 + 10p$	$\frac{6}{512} \times 4 + 10p$	$\frac{9}{512} \times 4 + 10p$
x	$11 \frac{13}{1024} \times 4 + 11p$	$\frac{10}{1024} \times 4 + 11p$	$\frac{2}{1024} \times 4 + 11p$	$\frac{9}{1024} \times 4 + 11p$
x <sup>12</sup>	$12 \frac{18}{2048} \times 4 + 12p$	$\frac{19}{2048} \times 4 + 12p$	$\frac{14}{1048} \times 4 + 12p$	$\frac{4}{2048} \times 4 + 12p$
	<i>&amp;c.</i>	<i>&amp;c.</i>	<i>&amp;c.</i>	<i>&amp;c.</i>

Jam vero Series istæ sunt convergentes, adeoque singulæ sum-  
 mari possunt per vulgarem Arithmeticam ; & obtinebuntur  
 vel summæ accuratæ si possint, vel saltem approximatae, si non  
 liceat, terminos multos adhibere.

Inveni-

*Invenire summas Probabilitatum ad infinitum usque pergentium, quas Collusores habent ut victores evadant.*

Sint Probabilitates omnes ipsius *B* ad infinitum, nempe  
 $B' + B'' + B''' + B'''' + B^v + B^{vi} \&c. = \gamma$

Probabilitates ipsius *C*  
 $C' + C'' + C''' + C'''' + C^v + C^{vi} \&c. = \varepsilon$

Probabilitates ipsius *D*  
 $D' + D'' + D''' + D'''' + D^v + D^{vi} \&c. = \nu$

Probabilitates ipsius *A*  
 $A' + A'' + A''' + A'''' + A^v + A^{vi} \&c. = x$

Scribantur autem in Scala perpendiculariter descendente, ad hunc modum.

$$\begin{aligned} B' &= B' \\ B'' &= B'' \\ B' &= \frac{1}{2} A'' + \frac{1}{4} A' \\ B'''' &= \frac{1}{2} A'' + \frac{1}{4} A'' \\ B^v &= \frac{1}{2} A'''' + \frac{1}{4} A''' \\ B^{vi} &= \frac{1}{2} A^v + \frac{1}{4} A'''' \\ \text{Ergo } \gamma &= \frac{1}{4} + \frac{1}{2} x + \frac{1}{4} x. \end{aligned} \quad \text{Proinde } \gamma = \frac{1}{4} + \frac{1}{4} x.$$

### *Demonstratio.*

Etenim prima columna perpendicularis =  $\gamma$ , ex Hypothesi  
 Est vero  $A' + A'' + A''' + A'''' + A^v \&c. = x$ , ex hypothesi ;  
 Ergo  $\frac{1}{2} A' + \frac{1}{2} A'' + \frac{1}{2} A''' + \frac{1}{2} A'''' + \frac{1}{2} A^v \&c. = \frac{1}{2} x$ .  
 Proinde  $\frac{1}{2} A'' + \frac{1}{2} A''' + \frac{1}{2} A'''' + \frac{1}{2} A^v \&c. = \frac{1}{2} x - \frac{1}{2} A'$ .  
 Et  $B' + B'' + \frac{1}{2} A'' + \frac{1}{2} A''' + \frac{1}{2} A'''' \&c. = \frac{1}{2} x - \frac{1}{2} A' + B' + B''$ .

Sed

( 150 )

Sed  $\frac{1}{2} A' = \bar{0}, B'' = 0$  &  $B' = \frac{1}{4}$ , ut patet ex Tabula:

Ergo secunda columna perpendicularis  $= \frac{1}{4} + \frac{1}{2} x$ .

Sed tertia columna perpendicularis  $= \frac{1}{4} x$ .

erit igitur  $y = \frac{1}{4} + \frac{3}{4} x$ .

Simili modo scribantur

$$C' = C'$$

$$C'' = C''$$

$$C''' = \frac{1}{2} B'' + \frac{1}{4} D'$$

$$C'''' = \frac{1}{2} B''' + \frac{1}{4} D'' \quad \text{hoc est } z = \frac{1}{2} y + \frac{1}{4} w$$

$$C^v = \frac{1}{2} B'''' + \frac{1}{4} D'''$$

$$C^{vi} = \frac{1}{2} B^{v'} + \frac{1}{4} D''''$$

¶ c.

Ergo  $z = \frac{1}{8} + \frac{1}{2} y + \frac{1}{8} + \frac{1}{4} w$ .

Scribantur etiam

$$D' = D'$$

$$D'' = D''$$

$$D''' = \frac{1}{2} C'' + \frac{1}{4} B'$$

$$D'''' = \frac{1}{2} C''' + \frac{1}{4} B''$$

$$D^v = \frac{1}{2} C'''' + \frac{1}{4} B'''$$

$$D^{vi} = \frac{1}{2} C^{v'} + \frac{1}{4} B''''$$

¶ c.

& pari Argumento patebit

$$v + \frac{1}{2} z + \frac{1}{4} y$$

Scribantur denique

$$A' = A'$$

$$A'' = A''$$

$$A''' = \frac{1}{2} D'' + \frac{1}{4} C'$$

$$A'''' = \frac{1}{2} D''' + \frac{1}{4} C''$$

$$A^v = \frac{1}{2} D'''' + \frac{1}{4} C'''$$

$$A^{vi} = \frac{1}{2} D^{v'} + \frac{1}{4} C''''$$

¶ c.

Unde concludetur  $x = \frac{1}{2} v + \frac{1}{4} z$

Resolutis autem quatuor istis æquationibus, reperietur

$$B' + B'' + B''' + B'''' \&c. = \gamma = \frac{56}{149}$$

$$C' + C'' + C''' + C'''' \&c. = z = \frac{36}{149}$$

$$D' + D'' + D''' + D'''' \&c. = v = \frac{32}{149}$$

$$A' + A'' + A''' + A'''' \&c. = x = \frac{25}{149}$$

Valoribus istis inventis, ponatur jam  $\frac{56}{149} = b$ ,  $\frac{36}{149} = c$ ,

$$\frac{32}{149} = d, \frac{25}{149} = a.$$

Iterum sit.

$$3 B' p + 4 B'' p + 5 B''' p + 6 B'''' p \&c. = p \gamma.$$

$$3 C' p + 4 C'' p + 5 C''' p + 6 C'''' p \&c. = p z.$$

$$3 D' p + 4 D'' p + 5 D''' p + 6 D'''' p \&c. = p v.$$

$$3 A' p + 4 A'' p + 5 A''' p + 6 A'''' p \&c. = p x.$$

$$3 B' = 3 B'$$

$$4 B'' = 4 B''$$

$$5 B''' = \frac{5}{2} A'' + \frac{5}{4} A'$$

$$6 B'''' = \frac{6}{2} A''' + \frac{6}{4} A''$$

$$7 B^v = \frac{7}{2} A'''' + \frac{7}{4} A'''$$

$$8 B^v = \frac{8}{2} A^v + \frac{8}{4} A''''$$

$$\text{Ergo } \gamma = \frac{5}{4} + \frac{3}{4} x + a$$

Etenim prima Columna perpendicularis  $= \gamma$ , ex Hypothesi :

$$3 B' + 4 B'' = \frac{3}{4} : \text{Nam est } B' = \frac{1}{4}, \& B'' = 0.$$

$$3 A' + 4 A'' + 5 A''' \&c. = x \text{ ex Hypothesi.}$$

$$A' + A'' + A''' \&c. = a, \text{ ut repertum est.}$$

$$\text{Est igitur } 4 A' + 5 A'' + 6 A''' + 7 A'''' \&c. = x + a$$

$$\text{Et } \frac{4}{2} A + \frac{5}{2} A'' + \frac{6}{2} A'' + \frac{7}{2} A'''' \&c. = \frac{1}{2} x + \frac{1}{2} a.$$

Sed  $A' = 0$

Ergo secunda Columna perpendicularis  $= \frac{3}{4} + \frac{1}{2} x + \frac{1}{2} a$ .

$$3 A' + 4 A'' + 5 A''' + 6 A'''' \&c. = x$$

$$2 A' + 2 A'' + 2 A''' + 2 A'''' \&c. = 2 a$$

Est igitur  $5 A' + 6 A'' + 7 A''' + 8 A'''' \&c. = x + 2 a$ .

Et  $\frac{5}{4} A' + \frac{6}{4} A'' + \frac{7}{4} A''' + \frac{8}{4} A'''' \&c. = \frac{1}{4} x + \frac{1}{2} a$ .

Est igitur tertia Columna perpendicularis  $= \frac{1}{4} x + \frac{1}{2} a$ .

Erit igitur  $y = \frac{3}{4} + \frac{1}{2} x + \frac{1}{2} a + \frac{1}{4} x + \frac{1}{2} a$

sive  $y = \frac{3}{4} + \frac{1}{4} x + a$ , quod erat probandum.

$$3 C' = 3 C'$$

$$4 C'' = 4 C''$$

$$5 C''' = \frac{5}{2} B'' + \frac{5}{4} D'$$

$$6 C'''' = \frac{6}{2} B''' + \frac{6}{4} D''$$

$$7 C'''' = \frac{7}{2} B'''' + \frac{7}{4} D'''$$

$$8 C'''' = \frac{8}{2} B'''' + \frac{8}{4} D''''$$

$\&c.$

Ergo  $z = \frac{1}{2} y + \frac{1}{2} b + \frac{1}{4} v + \frac{1}{2} d$ .

Etenim prima Columna perpendicularis  $= z$ , ex Hypothesi.

$$3 C' + 4 C'' = \frac{1}{2}$$

$$3 B' + 4 B'' + 5 B''' + 6 B'''' \&c. = y$$

$$B' + B'' + B''' + B'''' \&c. = b$$

Est igitur  $4 B' + 5 B'' + 6 B''' + 7 B'''' \&c. = y + b$ .

Sed  $4 B' = 1$ .

Ergo  $5 B'' + 6 B''' + 7 B'''' \&c. = y + b - 1$ .

$$\frac{5}{2} B'' + \frac{6}{2} B''' + \frac{7}{2} B'''' \&c. = \frac{1}{2} y + \frac{1}{2} b - \frac{1}{2}$$

Ergo secunda Columna perpendicularis  $= \frac{1}{2} + \frac{1}{2} y + \frac{1}{2} b - \frac{1}{2}$   
 $= \frac{1}{2} y + \frac{1}{2} b$ .

Iterum,  $3 D' + 4 D'' + 5 D''' + 6 D'''' \&c. = v$

$$2 D' + 2 D'' + 2 D''' + 2 D'''' \&c. = 2 d$$

Est igitur  $5 D' + 6 D'' + 7 D''' + 8 D'''' \&c. = v + 2 d$ .

$$\text{Et } \frac{5}{4} D' + \frac{6}{4} D'' + \frac{7}{4} D''' + \frac{8}{4} D'''' \&c. = \frac{1}{4} v + \frac{1}{2} d$$

Ergo tertia Columna perpendicularis  $= \frac{1}{4} v + \frac{1}{2} d$

Est igitur  $z = \frac{1}{2} y + \frac{1}{2} b + \frac{1}{4} v + \frac{1}{2} d$ , quod erat probandum.



Eodem prorsus ordine scribantur.

$$\begin{aligned} 3 D' &= 3 D' \\ 4 D'' &= 4 D'' \\ 5 D''' &= \frac{1}{2} C'' + \frac{1}{4} B' \\ 6 D'''' &= \frac{1}{2} C''' + \frac{1}{4} B'' \\ 7 D^V &= \frac{1}{2} C'''' + \frac{1}{4} B''' \\ 8 D^VI &= \frac{1}{2} C^V + \frac{1}{4} B'''' \end{aligned}$$

$\phi c.$

$$\text{Unde } v = \frac{1}{2} z + \frac{1}{2} c + \frac{1}{4} y + \frac{1}{2} b.$$

$$\begin{aligned} 3 A' &= 3 A' \\ 4 A'' &= 4 A'' \\ 5 A''' &= \frac{1}{2} D'' + \frac{1}{4} C' \\ 6 A'''' &= \frac{1}{2} D''' + \frac{1}{4} C'' \\ 7 A^V &= \frac{1}{2} D'''' + \frac{1}{4} C''' \\ 8 A^VI &= \frac{1}{2} D^V + \frac{1}{4} C'''' \end{aligned}$$

$\phi c.$

$$\text{Et } x = \frac{1}{2} v + \frac{1}{2} d + \frac{1}{4} z + \frac{1}{2} c.$$

Quæ quidem Conclusiones eodem modo demonstrantur ac superiores.

Solutis autem quatuor istis æquationibus, elicietur

$$y = \frac{45536}{149^2}, z = \frac{38724}{149^2}, v = \frac{37600}{149^2}, x = \frac{33547}{149^2} = \frac{33547}{22201}$$

Ergo, si velint  $B, C, D, A$  vendere Spectatori cuidam  $R$  summas quas singuli obtinere sperant, æquum erit ut emptor  $R$  pendat

$$\text{ipsi } B \quad 4 \times \frac{56}{149} + \frac{45536}{22201} p, \quad \text{ipsi } C \quad 4 \times \frac{36}{149} + \frac{38724}{22201} p.$$

$$\text{ipsi } D \quad 4 \times \frac{32}{149} + \frac{37600}{22201} p, \quad \text{ipsi } A \quad 4 \times \frac{25}{149} + \frac{33547}{22201} p.$$

*Invenire Probabilitates quas habent  $B, C, D, A$ , ut mulctentur, dato ludorum numero.*

Si Ludi duo tantum sint, erunt hoc modo.

$$\left. \begin{array}{l} \frac{BA}{CB} \quad \frac{BA}{BC} \end{array} \right\} \text{Unde patet } B \text{ vel } C \text{ necessario mulctari.}$$

Si Ludi tres fuerint, hoc modo se res habet.

$$\left. \begin{array}{l} \frac{BA}{CB} \quad \frac{BA}{CB} \quad \frac{BA}{BC} \quad \frac{BA}{BC} \\ \frac{DC}{CD} \quad \frac{CD}{DB} \quad \frac{DB}{BD} \quad \frac{BD}{BC} \end{array} \right\} \text{Hinc patet } C, \text{ vel } D \text{ vel } B \text{ necessario mulctari.}$$

Si vero quatuor Ludi fuerint:

$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	$\overline{BA}$	} Debet igitur $A$ triplici modo, $D$ duplici, $C$ simplici, mulctari.
$\overline{CB}$	$\overline{CB}$	$\overline{CB}$	$\overline{CB}$	$\overline{BC}$	$\overline{BC}$	
$\overline{DC}$	$\overline{DC}$	$\overline{CD}$	$\overline{CD}$	$\overline{DB}$	$\overline{DB}$	
$\overline{AD}$	$\overline{DA}$	$\overline{AC}$	$\overline{CA}$	$\overline{AD}$	$\overline{DA}$	

Et sic de cæteris. Ex quibus manifesta est Compositio Tabulæ subjunctæ Probabilitatum quas  $B, C, D, A$  habent ut mulctentur, dato ludorum numero.

	Num Lud.	B	C	D	A
I	2	$\frac{1}{2}$	$\frac{1}{2}$		
		$\frac{2}{2}$	$\frac{2}{2}$		
II	3	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{2}{4}$	
		$\frac{4}{4}$	$\frac{4}{4}$	$\frac{4}{4}$	
III	4		$\frac{1}{8}$	$\frac{2}{8}$	$\frac{3}{8}$
			$\frac{8}{8}$	$\frac{8}{8}$	$\frac{8}{8}$
IV	5	$\frac{3}{16}$	$\frac{2}{16}$	$\frac{2}{16}$	$\frac{3}{16}$
		$\frac{16}{16}$	$\frac{16}{16}$	$\frac{16}{16}$	$\frac{16}{16}$
V	6	$\frac{6}{32}$	$\frac{5}{32}$	$\frac{2}{32}$	$\frac{3}{32}$
		$\frac{32}{32}$	$\frac{32}{32}$	$\frac{32}{32}$	$\frac{32}{32}$
VI	7	$\frac{6}{64}$	$\frac{8}{64}$	$\frac{8}{64}$	$\frac{4}{64}$
		$\frac{64}{64}$	$\frac{64}{64}$	$\frac{64}{64}$	$\frac{64}{64}$
		<i>&amp;c.</i>			

Sint autem  $y, z, v, x$  summæ omnium Probabilitatum quas  $B, C, D, A$  habent respective ut mulctentur.

Scribantur eodem ordine ac in præcedentibus.

$$\begin{array}{ll}
 B' = B' & C' = C' \\
 B'' = B'' & C'' = C'' \\
 B''' = \frac{1}{2}A'' + \frac{1}{4}A' & C''' = \frac{1}{2}B'' + \frac{1}{4}D' \\
 B'''' = \frac{1}{2}A''' + \frac{1}{4}A'' & C'''' = \frac{1}{2}B''' + \frac{1}{4}D'' \\
 B^V = \frac{1}{2}A'''' + \frac{1}{4}A''' & C^V = \frac{1}{2}B'''' + \frac{1}{4}D''' \\
 B^{VI} = \frac{1}{2}A^V + \frac{1}{4}A'''' & C^{VI} = \frac{1}{2}B^V + \frac{1}{4}D'''' \\
 \text{\&c.} & \text{\&c.}
 \end{array}$$

$$\text{Ergo } y = \frac{3}{4} + \frac{1}{2}x + \frac{1}{4}x. \\
 = \frac{3}{4} + \frac{3}{4}x.$$

$$\text{Ergo } z = \frac{1}{2} + \frac{1}{2}y + \frac{1}{4}v.$$

Scri-

Scribantur deinde

$$D' = D'$$

$$D'' = D''$$

$$D''' = \frac{1}{2} C' + \frac{1}{4} B'$$

$$D'''' = \frac{1}{2} C'' + \frac{1}{4} B''$$

$$D^v = \frac{1}{2} C''' + \frac{1}{4} B'''$$

$$D^v = \frac{1}{2} C^v + \frac{1}{4} B^v$$

*Ec.*

$$\text{Ergo } v = \frac{1}{4} + \frac{1}{2} z + \frac{1}{4} y.$$

$$A' = A'$$

$$A'' = A''$$

$$A''' = \frac{1}{2} D' + \frac{1}{4} C'$$

$$A'''' = \frac{1}{2} D'' + \frac{1}{4} C''$$

$$A^v = \frac{1}{2} D''' + \frac{1}{4} C'''$$

$$A^v = \frac{1}{2} D^v + \frac{1}{4} C^v$$

*Ec.*

$$\text{Ergo } x = \frac{1}{2} v + \frac{1}{4} z.$$

Resolutis autem quatuor istis æquationibus, invenietur

$$y = \frac{243}{249} \quad z = \frac{252}{149} \quad v = \frac{224}{149} \quad \& x = \frac{175}{149}$$

Ergo si velit Spectator aliquis  $S$  multas omnes sustinere, æquum erit ut ipsi  $S$

$$B \text{ tradat } \frac{243}{149} p \quad C \frac{252}{149} p \quad D \frac{224}{149} p \quad \& A \frac{175}{149} p.$$

Sublatis itaque summis probabilitatum quas singuli Collutores habent ut multentur, è summis expectationum quas habent iidem si victores abeant, restabunt fortes eorum respective : nempe

$$B \text{ recipit ab } R \quad \frac{4 \times 56}{149} + \frac{45336}{22201} p$$

$$B \text{ tradit ipsi } S \quad \frac{243}{149} p$$

$$\text{Ergo ipsi } B \text{ superest } \frac{224}{149} + \frac{9329}{22201} p$$

Sed  $B$  deposuerat priusquam ludus inciperetur.

$$\text{Ergo } B \text{ lucratur } \frac{75}{149} + \frac{9329}{22201} p.$$

( 156 )

$$C \text{ recipit ab } R \quad \frac{4 \times 36}{149} \quad + \quad \frac{38724}{22201} p$$

$$C \text{ tradit ipsi } S \quad \frac{252}{149} p$$

$$\text{Ergo ipsi } C \text{ superest } \frac{144}{149} \quad + \quad \frac{1176}{22201} p$$

Sed  $C$  deposuerat 1.

$$\text{Ergo } C \text{ lucratur } - \frac{5}{149} \quad + \quad \frac{1176}{22201} p.$$

$$D \text{ recipit ab } R \quad \frac{4 \times 32}{149} \quad + \quad \frac{37600}{22201} p$$

$$D \text{ tradit ipsi } S \quad \frac{224}{149} p$$

$$\text{Ergo ipsi } D \text{ superest } \frac{128}{149} \quad + \quad \frac{4224}{22201} p$$

Sed  $D$  deposuerat 1.

$$\text{Ergo } D \text{ lucratur } - \frac{21}{149} \quad + \quad \frac{4224}{22201} p.$$

$$A \text{ recipit ab } R \quad \frac{4 \times 25}{149} \quad + \quad \frac{33547}{22201} p$$

$$A \text{ tradit ipsi } S \quad \frac{175}{149} p$$

$$\text{Ergo ipsi } A \text{ superest } \frac{100}{149} \quad + \quad \frac{7472}{22201} p$$

Sed  $A$  deposuerat  $1 + p$ , nempe 1 priusquam ludus inchoaretur, &  $p$  postquam semel victus fuerat à  $B$ :

$$\text{Ergo } A \text{ lucratur } - \frac{49}{149} \quad - \quad \frac{14729}{22201} p.$$

**Lucrum**

$$\text{Lucrum ipsius } B = + \frac{75}{149} + \frac{9329}{22201} p$$

$$\text{ipsius } C = - \frac{5}{149} + \frac{1176}{22201} p$$

$$\text{ipsius } D = - \frac{21}{149} + \frac{4224}{22201} p$$

$$\text{ipsius } A = - \frac{49}{149} - \frac{14729}{22201} p$$

$$\text{Summa Lucrorum} = \quad 0 \quad 0$$

$$\text{Summa autem lucrorum ipsorum } B \& A = \frac{26}{149} - \frac{5400}{22201} p ;$$

sed posueramus  $B$  vicisse ipsum  $A$  semel, priusquam Collusores pacta inirent cum  $R$  &  $S$ . Priusquam vero ludus inchoaretur,  $A$  poterat æqua sorte expectare ut vinceret ipsum  $B$ ,

adeoque summa lucrorum  $\frac{26}{149} - \frac{5400}{22201}$  in duas partes æqua-

les est dividenda, ita ut utriusque lucrum censendum sit  $\frac{13}{149} - \frac{2700}{22201} p$ .

$$\text{Ponatur } \frac{13}{149} - \frac{2700}{22201} p = 0, \& \text{ erit } p = \frac{1937}{2700}.$$

Ergo si sit multa  $p$  ad summam quam singuli deponunt ut 1937 ad 2700,  $A$  &  $B$  nihil lucrantur, nihil perdunt. Verum

hoc in Casu  $C$  lucratur  $\frac{1}{225}$ , quam  $D$  perdit.

*Coroll. 1.* Spectator  $R$ , priusquam ludus inchoetur, id suscipere in se poterit, ut summam 4 de qua Collusores contendunt, & multas omnes pendat, si sibi initio in manus darentur  $4 + 7 p$ .

*Coroll. 2.* Si dexteritates Collusorum sint in ratione data, sortes Collusorum eadem ratiocinatione determinabuntur.

*Coroll. 3.* Si Series aliqua ita sit constituta, ut continuò decrescat, & terminus quivis ad præcedentes quoslibet habeat rationes datas, sive easdem sive diversas, series ista accurate summabitur. Insuper si termini omnes hujus Series multiplicentur per terminos progressionis Arithmeticæ, singuli per singulos, Series nova resultans accurate summabitur.

*Coroll. 4.* Si sint Series plures collaterales, ita relatæ ut terminus quilibet cujusque Series ad præcedentes quoslibet aliarum Serierum habeat rationes datas, sive easdem sive diversas, ita ut Series istæ collaterales se decussent data qualibet lege constanti, Series istæ accurate summabuntur. Insuper si termini omnes harum Serierum multiplicentur ordinatim per terminos Progressionis Arithmeticæ, singuli per singulos, Series novæ ex hac multiplicatione resultantes etiamnum accurate summabuntur.

### *Clavis ad Problema generale.*

Si sint Collusores quotcunque *v. g.* Sex, *B, C, D, E, F, A* & Probabilitates quas habent ut victores evadant, sive ut mulctentur, dato Ludorum numero, denotentur respective *B, C, D, E, F & A*; & Probabilitates dato Ludorum numero his proximo & minori competentes, per *B<sub>II</sub>, C<sub>II</sub>, D<sub>II</sub>, E<sub>II</sub>, F<sub>II</sub>, A<sub>II</sub>*; & Probabilitates dato Ludorum numero his itidem novissimis proximo & minori competentes, per *B<sub>III</sub>, C<sub>III</sub>, D<sub>III</sub>, E<sub>III</sub>, F<sub>III</sub>, A<sub>III</sub>*, & sic deinceps; erit semper,

$$\begin{aligned} B_I &= \frac{1}{2}A_{II} + \frac{1}{4}A_{III} + \frac{1}{8}A_{IV} + \frac{1}{16}A_V \\ C_I &= \frac{1}{2}B_{II} + \frac{1}{4}F_{III} + \frac{1}{8}E_{IV} + \frac{1}{16}D_V \\ D_I &= \frac{1}{2}C_{II} + \frac{1}{4}B_{III} + \frac{1}{8}F_{IV} + \frac{1}{16}E_V \\ E_I &= \frac{1}{2}D_{II} + \frac{1}{4}C_{III} + \frac{1}{8}B_{IV} + \frac{1}{16}F_V \\ F_I &= \frac{1}{2}E_{II} + \frac{1}{4}D_{III} + \frac{1}{8}C_{IV} + \frac{1}{16}B_V \\ A_I &= \frac{1}{2}F_{II} + \frac{1}{4}E_{III} + \frac{1}{8}D_{IV} + \frac{1}{16}C_V \end{aligned}$$

Et fiat semper retrogressus ordinatim ad tot literas minus duobus quot sunt Collusores, omittaturque semper litera *A*, prima æquatione excepta, ubi litera *A* terminos omnes præter primam occupat.

Depositem	hrs	Depositem	hrs	Deposit.
$n+1$	0	$Z$	$n+1+p$	$H$
$n+1+p$	1	$Y$	$n+1+2p$	$K$
$n+1+2p$	2	$X$	$n+1+3p$	$L$
$n+1+3p$	3	$V$	$n+1+4p$	$M$
$n+1+4p$	4	$T$		

N. 3

$$\begin{aligned}
 &= \frac{1}{2} \times \overline{AT} - p + \frac{1}{2} \times \overline{H} - p + hp + \frac{1}{8} \times \overline{H} - p + 2hp + \frac{1}{16} \times \overline{H} - p + 3hp + \dots - \frac{1}{2^n} \times \overline{H} - p + nhp - hp + \frac{1}{2^n} \times np + n + 1 \\
 &= \frac{1}{2} \times \overline{K} - p + \frac{1}{2} \times \overline{H} - p + 2hp + \frac{1}{8} \times \overline{H} - p + 3hp + \frac{1}{16} \times \overline{H} - p + 4hp + \dots - \frac{1}{2^n} \times \overline{H} - p + nhp + \frac{1}{2^n} \times np + p + n + 1 \\
 &= \frac{1}{2} \times \overline{L} - p + \frac{1}{2} \times \overline{H} - p + 3hp + \frac{1}{8} \times \overline{H} - p + 4hp + \frac{1}{16} \times \overline{H} - p + 5hp + \dots - \frac{1}{2^n} \times \overline{H} - p + nhp + hp + \frac{1}{2^n} \times np + 2p + n + 1 \\
 &= \frac{1}{2} \times \overline{M} - p + \frac{1}{2} \times \overline{H} - p + 4hp + \frac{1}{8} \times \overline{H} - p + 5hp + \frac{1}{16} \times \overline{H} - p + 6hp + \dots - \frac{1}{2^n} \times \overline{H} - p + nhp + hp + \frac{1}{2^n} \times np + 3p + n + 1
 \end{aligned}$$

N. 4

$$\begin{aligned}
 &= \frac{1}{2^{n-1}} \times \overline{C} + ncp - cp + \frac{1}{2^{n-2}} \times \overline{D} + ndp - dp + \frac{1}{2^{n-3}} \times \overline{E} + nep - 3cp + \frac{1}{2^{n-4}} \times \overline{F} + nfp - 4fp + \dots \\
 &= \frac{1}{2^{n-2}} \times \overline{D} + ndp - dp + \frac{1}{2^{n-3}} \times \overline{E} + nep - 2cp + \frac{1}{2^{n-4}} \times \overline{F} + nfp - 3fp + \dots \\
 &= \frac{1}{2^{n-3}} \times \overline{E} + nep - cp + \frac{1}{2^{n-4}} \times \overline{F} + nfp - 2fp + \dots \\
 &= \frac{1}{2^{n-4}} \times \overline{F} + nfp - fp + \dots
 \end{aligned}$$

N. 4

N. 6

N. 8

$$\begin{aligned}
 -Z &= \frac{1}{2} K - \frac{1}{2} H + \frac{1}{2} hp + \frac{1}{8} hp + \frac{1}{16} hp + \dots - \frac{1}{2^n} \times hp = \frac{1}{2} K - \frac{1}{2} H + zp - \frac{1}{2} hp = -\frac{1}{2^{n-2}} \times C - \frac{ncp}{2^n} + zp \\
 -Y &= \frac{1}{2} L - \frac{1}{2} K + \frac{1}{2} hp + \frac{1}{8} hp + \frac{1}{16} hp + \dots - \frac{1}{2^n} \times hp = \frac{1}{2} L - \frac{1}{2} K + zp - \frac{1}{2} hp = -\frac{1}{2^{n-1}} \times D - \frac{ndp}{2^{n-1}} - \frac{cp}{2^n} + zp \\
 -X &= \frac{1}{2} M - \frac{1}{2} L + \frac{1}{2} hp + \frac{1}{8} hp + \frac{1}{16} hp + \dots - \frac{1}{2^n} \times hp = \frac{1}{2} M - \frac{1}{2} L + zp - \frac{1}{2} hp = -\frac{1}{2^{n-2}} \times E - \frac{nep}{2^{n-2}} - \frac{dp}{2^{n-1}} - \frac{cp}{2^n} + zp
 \end{aligned}$$

N. 5

N. 7

$$\begin{aligned}
 -H &= -\frac{1}{2^{n-1}} \times \overline{C} + ncp - cp + \frac{1}{2^{n-2}} \times dp + \frac{1}{2^{n-3}} \times cp + \frac{1}{2^{n-4}} \times fp + \dots = -\frac{1}{2^{n-1}} \times C - \frac{ncp}{2^{n-1}} + hp \\
 -K &= -\frac{1}{2^{n-2}} \times \overline{D} + ndp - dp + \frac{1}{2^{n-3}} \times cp + \frac{1}{2^{n-4}} \times fp + \dots = -\frac{1}{2^{n-2}} \times D - \frac{ndp}{2^{n-2}} - \frac{cp}{2^{n-1}} + hp \\
 -L &= -\frac{1}{2^{n-3}} \times \overline{E} + nep - cp + \frac{1}{2^{n-4}} \times fp + \dots = -\frac{1}{2^{n-3}} \times E - \frac{nep}{2^{n-3}} - \frac{dp}{2^{n-2}} - \frac{cp}{2^{n-1}} + hp
 \end{aligned}$$

N. 9

N. 10

N. 8

$$\begin{aligned}
 Z &= A & C - A &= Y - Z = -\frac{1}{2^n} \times C - \frac{ncp}{2^n} + zp \\
 C &= C & 2D - 2C - cp &= X - Y = -\frac{1}{2^{n-1}} \times D - \frac{ndp}{2^{n-1}} - \frac{cp}{2^n} + zp \\
 2D - C - cp &= 2D - C - cp & 4E - 4D - 2dp - cp &= V - X = -\frac{1}{2^{n-2}} \times E - \frac{nep}{2^{n-2}} - \frac{dp}{2^{n-1}} - \frac{cp}{2^n} + zp
 \end{aligned}$$

N. 11

$$\begin{aligned}
 Z &= \frac{A \times 2^n + ap \times 2^n - ncp}{1 + 2^n} & &= \frac{\frac{1}{2} + ap \times 2^n - ncp}{1 + 2^n} \\
 C &= \frac{C \times 2^n + cp \times 2^{n-1} - \frac{1}{2} + ap \times 2^{n-1} - ndp}{1 + 2^n} & &= \frac{C + cp \times 2^n - ndp}{1 + 2^n} \\
 D &= \frac{D \times 2^n + dp \times 2^{n-1} - \frac{1}{2} + cp \times 2^{n-1} - \frac{1}{2} + ap \times 2^{n-2} - ncp}{1 + 2^n} & &= \frac{D + dp \times 2^n - ncp}{1 + 2^n}
 \end{aligned}$$

IV. *An Account of several extraordinary Meteors or Lights in the Sky.* By Dr. Edmund Halley, Savilian Professor of Geometry at Oxon, and Secretary to the Royal-Society.

THE *Theory* of the Air seemeth, at present, to be perfectly well understood, and the differing Densities thereof at all Altitudes, both by Reason and Experiment are sufficiently defined; for supposing the same Air to occupy Spaces reciprocally proportional to the Quantity of the superior or incumbent Air, I have elsewhere proved that at 40 Miles high the Air is rarer than at the Surface of the Earth about 3000 times; and that the utmost Height of the Atmosphere, which reflects Light in the *Crepusculum*, is not fully 45 Miles. Notwithstanding which, 'tis still manifest that some sort of Vapours, and those in no small Quantity, arise nearly to that Height. An Instance of this may be given in the great Light the Society had an account of (*vid. Transact.* Sept. 1676) from Dr. Wallis, which was seen in very distant Counties almost over all the South Part of *England*. Of which though the Doctor could not get so particular a Relation, as was requisite to determine the Height thereof, yet from the distant Places it was seen in, it could not but be very many Miles high.

So likewise that Meteor which was seen in 1708. on the 31<sup>st</sup> of *July*, between Nine and Ten a Clock at Night, was evidently between 40 and 50 Miles perpendicularly high, and as near as I can gather, over *Shereness* and the *Buoy on the Nore*. For it was seen at *London* moving horizontally from *E. by N.* to *E. by S.* at least 50 Degrees high, and at *Redgrave* in *Suffolk*, on the *Yarmouth* Road, about 20 Miles from the East Coast of *England*, and at least 40 Miles to the Eastward of *London*, it appeared a little to the Westwards of the South, suppose *S. by W.* and was seen about 30 Degrees high, sliding obliquely downwards. I was shown in both Places the Situation thereof, which was as described, but could with some Person skill'd in Astronomical Matters had seen it,



that we might pronounce concerning its Height with more certainty : Yet, as it is, we may securely conclude, that it was not many Miles more Westerly than *Redgrave*, which, as I said before, is above 40 Miles more Easterly than *London*. Suppose it therefore, where perpendicular, to have been 35 Miles East from *London*, and by the Altitude it appear'd at in *London*, viz. 50 Degrees, its Tangent will be 42 Miles, for the Height of the Meteor above the Surface of the Earth; which also is rather of the least, because the Altitude of the Place shewn me, is rather more than less than 50 Degrees : and the like may be concluded from the Altitude it appear'd in at *Redgrave*, near 70 Miles distant. Though at this great Distance, it appear'd to move with an incredible Velocity, darting, in a very few Seconds of Time, for about 12 Degrees of a great Circle from North to South, being very bright at its first Appearance ; and it died away at the End of its Course, leaving for some time a pale Whiteness in the Place, with some Remains of it in the Track where it had gone ; but no hissing Sound as it pass'd, or Bounce of an Explosion were heard.

It may deserve the Honourable Society's Thoughts, how so great a Quantity of Vapour should be rais'd to the very Top of the Atmosphere, and there collected, so as upon its Accension or otherwise Illumination, to give a Light to a Circle of above 100 Miles Diameter, not much inferior to the Light of the Moon ; so as one might see to take a Pin from the Ground in the otherwise dark Night. 'Tis hard to conceive what sort of Exhalations should rise from the Earth, either by the Action of the Sun or subterranean Heat, so as to surmount the extream Cold and Rareness of the Air in those upper Regions : But the Fact is indisputable, and therefore requires a Solution.

Like to this, but much more considerable, was that famous Meteor which was seen to pass over *Italy* on the 21<sup>st</sup> of March O. S. Anno 1676. about an Hour and Three Quarters after Sun set, which happen'd to be observed and well consider'd by the famous Professor of Mathematicks in *Bononia*

*Geminian Montanari*, as may be seen in his *Italian Treatise* about it, soon after published at *Bononia*. He observes that at *Bononia*, its greatest Altitude in the *S. S. E.* was 38 Degrees, and at *Sienna* 58 to the *N. N. W.*: that its Course by the Concurrence of all the Observers was from *E. N. E.* to *W. S. W.* that it came over the *Adriatick Sea* as from *Dalmatia*: that it crost over all *Italy*, being nearly vertical to *Rimini* and *Savigniano* on the one Side, and to *Leghorn* on the other: that its perpendicular Altitude was at least 38 Miles: that in all Places near this Course. it was heard to make a hissing Noise as it passed; *Ronzare, Far strepito comme un fuoco artificiale, Fisciare per aria comme un Raggio di polve*; that having past over *Leghorn* it went off to Sea towards *Corfica*, and lastly that at *Leghorn* it was heard to give a very great Blow, *Tuono di maggior rumore di grossa Cannonata*; immediately after which another sort of Sound was heard like the rattling of a great Cart running over Stones, which continued about the time of a *Credo*.

He concludes from the apparent Velocity it went on with at *Bononia*, at above 50 Miles Distance, that it could not be less swift than 160 Miles in a Minute of Time, which is above Ten times as swift as the diurnal Rotation of the Earth under the Equinoctial, and not many times less than that wherewith the annual Motion of the Earth about the Sun is performed. To this he adds the Magnitude thereof, which appeared at *Bononia* bigger than the Moon in one Diameter, and above half as big again in the other; which with the given Distance of the Eye, makes its real lesser Diameter above half a Mile, and the other in proportion. This supposed, it cannot be wondred that so great a Body moving with such an incredible Velocity through the Air, though so much rarified as it is in its upper Regions, should occasion so great a hissing Noise, as to be heard at such a Distance as it seems this was. But 'twill be much harder to conceive, how such an *impetus* could be impressed on the Body thereof, which by many Degrees exceeds that of any Cannon Ball; and how

this *impetus* shou'd be determined in a Direction so nearly parallel to the Horizon; and what sort of Substance it must be, that could be so impelled and ignited at the same time: there being no *Vulcano* or other *Spiraculum* of subterraneous Fire in the *N. E.* parts of the World, that we ever yet heard of, from whence it might be projected.

I have much considered this Appearance, and think it one of the hardest things to account for, that I have yet met with in the *Phænomena* of *Meteors*, and am induced to think that it must be some Collection of Matter form'd in the *Æther*, as it were by some fortuitous Concourse of Atoms, and that the Earth met with it as it past along in its Orb, then but newly formed, and before it had conceived any great *Impetus* of Descent towards the Sun. For the Direction of it was exactly opposite to that of the Earth, which made an Angle with the Meridian at that time (the Sun being in about 11 Degrees of *Aries*) of 67 Gr. that is, its Course was from *W. S. W.* to *E. N. E.* wherefore the *Meteor* seem'd to move the contrary Way: And besides falling into the Power of the Earth's Gravity, and losing its Motion from the Opposition of the *Medium*, it seems that it descended towards the Earth, and was extinguish'd in the *Tyrrhene Sea*, to the *W. S. W.* of *Leghorn*. The great Blow being heard upon its first Immersion into the Water, and the rattling like the driving a Cart over Stones being what succeeded upon its quenching; something like which is always observed upon quenching a very hot Iron in Water. These Facts being past dispute, I would be glad to have the Opinion of the Learned thereon, and what Objection can be reasonably made against the abovesaid *Hypothesis*, which I humbly submit to their Censure.

*P. S.* Since this was written, there has fallen into my Hands an Account of much such another Appearance, seen in *Germany*, in the Year 1686, at *Leipsic*, by the late Mr. *Gottfreid Kirch*, who was for many years a very diligent Observer of the  
Heavens'

Heavens, and perfectly well instructed in Astronomical Matters. He in an Appendix to his *Ephemerides* for the Year 1688, gives us this remarkable Relation in the following Words.

*Die 9 Jul. lt. vct. Hora 1 ½ matutina, Globus ardens cauda præditus in 8 ½ Gr. Aquarii & 4 Gr. Sept. apparuit, qui per semi-quadrantem Hora immotus perstitit, cujus diameter semidiametrum Lune circiter æquabat. Primo lux tanta erat, ut ejus ope sine candelis legere potuiffemus: postea pedetentim in loco suo evanescebat. Phenomenon istud dicto tempore multis aliis in locis pariter visum est, præsertim Schlaizii, oppido undecim milliaribus Germanicis abhinc (i. e. a Lipsiâ) versus Meridiem distante, altitudine circiter 60 Gr. ab Horizonte meridiano.*

At the time of this Appearance the Sun was in  $26 \frac{1}{2}$  Gr. of  $\text{♋}$ , and by the given Place of the Meteor, 'tis plain, it was seen about  $\frac{3}{4}$  of an Hour past the Meridian, or in S. by W. and by its Declination it could not be above 24 Degrees high at *Leipsic*, though the same, at *Schlaize* was about 60 Gr. high: The Angle therefore at the Meteor was about 36 Gr. Whence by an easy *calculus* it will be found, that the same was not less than 16 German Miles distant in a right Line from *Leipsick*, and above  $6 \frac{1}{2}$  such Miles perpendicular above the Horizon, that is at least 30 English Miles high in the Air. And though the Observer says of it, *immutus perstitit per semi-quadrantem hora*; 'tis not to be understood that it kept its Place like a Fixt Star, all the time of its Appearance; but that it had no very remarkable progressive Motion. For himself has at the End of the said *Ephemerides* given a Figure of it, which he has marked *Fig. D.* whereby it appears that it darted downwards obliquely to the Right Hand, and where it ended, left two Globules or Nodes, not visible but by an Optick Tube.

The same Mr. *Gottfried Kirch* in the beginning of a German Treatise of his, concerning the great Comet which appeared in the Year 1680, intituled *Neue himmels-zeitung*,

printed at *Nuremburg* anno 1681, (of which perhaps we shall have further occasion to make mention) gives us a Relation of such another luminous Meteor seen likewise at *Leipsick* on the 22<sup>d</sup> of *May* 1680. *ft. vet.* about three in the Morning: which though himself saw not, was yet there observ'd by divers Persons who made various Reports of it, but the more intelligent agreed that it was seen descending in the North, and left behind it a long white Streak where it had past. At the same time at *Haarburgh* the like Appearance was seen in *N.E.* or rather *N.N.E.*; as also at *Hamburg, Lubeck* and *Stralsund*, all which are about 40 *German Miles* from *Leipsick*: but in all these Places, by Persons unacquainted with the manner of properly describing things of this kind. So that all we can conclude from it is, that this Meteor was exceeding high above the Earth, as well as the former.

All the Circumstances of these *Phanomena* agree with what was seen in *England* in 1708, but it commonly so happens that these contingent Appearances escape the Eyes of those that are best qualified to give a good Account of them. 'Tis plain however that this sort of luminous Vapour is not exceedingly seldom thus collected; and when the like shall again happen, the Curious are entreated to take more Notice of them than has been hitherto done, that we may be enabled thereby better to account for the surprizing Appearances of this sort of *Meteor*.

V. *Some Remarks on the Variations of the Magnetical Compass published in the Memoirs of the Royal Academy of Sciences, with regard to the General Chart of those Variations made by E. Halley; as also concerning the true Longitude of the Magellan Streights.*

**I**T must be acknowledged that the Gentlemen of the *Royal Academy of Sciences in France*, have, for some Years past, apply'd themselves with much Candour, as well as Diligence, to examine the Chart I publish'd in the Year 1701, for shewing at one View the Variations of the Magnetical Compass, in all those Seas with which the *English* Navigators are acquainted: And, to my no small Satisfaction, I find that what I did so long ago, has been since abundantly verified by the concurrent Reports of the *French* Pilots, who of late have had frequent Opportunities of enquiring into the Truth thereof. So that I am in hopes I have laid a sure Foundation for the future Discovery of an Invention, that will be of wonderful Use to Mankind when perfected; I mean that of the Law or Rule by which the said Variations change, in Appearance regularly, all the World over. Of this I have adventured long since to give my Thoughts in N<sup>o</sup> 148 and N<sup>o</sup> 195 of these *Transactions*, and as yet I see no Cause to retract what I there offer for a Reason of this Change; but of this we might be more certain, had we a good Collection of Observations made in that Ocean which divides *Asia* and *America*, and occupies about two fifths of the whole Circumference of the Globe. This, we hope, from the natural Curiosity of the *French* (who want no Means of performing it) may be effectually supply'd by such of that Nation who may return from *Peru* by the *East-Indies*.

In the mean time I cannot omit to take Notice of two Particulars, seeming to call in Question the Truth of my aforesaid Map, which I have lately observed in the *Memoirs* of the *Royal Academy of Sciences*.

The one is in the *Memoirs* of the Year 1700, concerning the Variation observed at *Paraíba* in *Brasile*, about 25 Leagues to the Northwards of *Pernambouc*, by M. Couplet *l' fils*, whose Words are these,

Le 20 Mai, 1698. ayant auparavant tracé seigneusement une ligne Meridienne, dont je m'étois servi pour les Observations Astronomiques, j'observai la déclinaison de l'aiguille aimantée de  $5^{\circ} 35'$  Nordouest. And the same Observer tells us, that he found the Latitude of the Town of *Paraíba*  $6^{\circ} 38' 18''$ . Now it so fell out, that my self was in the River of *Paraíba*, in the Month of *March*, 1699. and there fitted and cleaned my Ship, so that I had full Opportunity to observe the Variation both on Board and on Shore, and found it constantly to be above 4 Gr. *North-East*; so that I am willing to believe this to be an Error of the Press, putting N. W. for N. E; or rather of the Memory of M. Couplet, who, it seems, lost all his Papers by Shipwreck in his Return. The like may be said of the Latitude of *Paraíba*, which, though I did not observe my self, yet at the Fort of *Cabo Dello*, at the Mouth of the River, and which is about 3 Leagues more Northerly than the Town, I found the Latitude not less than  $6^{\circ} 55'$  South, and by Consequence that of the Town more than 7 Degrees.

The other is in a Discourse of M. de Lisle, in the *Memoirs* of 1710; where he compares the Variations observed in some late Voyages, with my Map of the Variations. Among other Things, 'tis there said, that on the East-side of the Island *St. Thomas*, under the Equinoctial Line, M. Bigot de La Canté, second Lieutenant of the King's Ship *la Sphere*, had, in the beginning of the Year 1708, found the Variation  $11\frac{1}{2}$  Gr. whereas my Chart makes it but  $5\frac{1}{2}$  Gr. 'Tis true, that I never observed my self in those Parts; and 'tis from

from the Accounts of others, and the Analogy of the whole, that in such Cases I was forc'd to supply what was wanting ; and 'tis possible that there may be more Variation on that Coast than I have allowed. But consulting my Chart ( which was fitted to the Year 1700 ) I find I then make the Variation at the Isle of *St. Thomas* full  $7\frac{1}{2}$  Gr. and not  $5\frac{1}{2}$  Gr. the which, by the Year 1708, might well arise to near 9 Gr. So that the Difference will become very tolerable ; whereas an Error of 6 Degrees, such as is here represented, would render the Credit of my Chart justly suspected, and the same by consequence wholly usefess, as not to be confided in.

But a further Thing I might complain of is, that in the same *Memoire* of *M. de Lisle*, the Geography of my Chart is called in Question ; and we are told that I have placed the Entrance of the *Magellan* Straights at least 10 Degrees more Westerly than I ought to have done : for that the Ship *St. Louis*, in the Year 1708, sailing from the Mouth of *Rio Gallega*, in about the Latitude of 52 Gr. South, and not far from Cape *Virgin*, directly for Cape *Bonne Esperance* ( which Course perhaps was never run before ) had found the Distance between the two Lands not more than 1350 Leagues, which, he concludes, is much less than my Chart of the Variation makes it. I know not from what Computation *M. de Lisle* has deduced this Consequence, but I find by my Chart that I have made the Longitude of *Rio Gallega* 75 Gr. West from London, and that of Cape *Bonne Esperance*  $16\frac{1}{2}$  East from it ; that is in all  $91\frac{1}{2}$  Gr. difference of Longitude. This, with the two Latitudes, gives the Distance, according to the Rhumb-line 1364 Leagues, but according to the Arch of a great Circle, no more than 1287 Leagues ; so that instead of invalidating what I have there laid down, it does absolutely confirm it, as far as the Authority of one single Ship's Journals can do it.



I do not pretend that I have had Observations made with all the Precision requisite, to lay down incontestably the *Magellan Straights* in their true Geographical Site; but yet it has not been without good Grounds that I have placed them as I have done. For when Sir *John Narborough*, in the Year 1670, wintered in Port *St. Julian*, on the Coast of *Patagonia*, Capt. *John Wood*, then his Lieutenant, and an approved Artist in Sea Affairs, did observe the beginning of an Eclipse of the Moon, *Sept. 18<sup>vo</sup> Stil. vet.* at just 8 at Night: And the same beginning was observ'd by M. *Hevelius* at *Dantzick* at 14<sup>h</sup> 22'; whence Port *St. Julian* is more Westerly than *Dantzick* 6<sup>h</sup> 22', or than *London* 5<sup>h</sup> 6, that is 76½ Gr. Besides, I have had in my Custody a very curious Journal of one Capt. *Strong*, who went into the *South Seas* in quest of a rich Plate-wreck, and who discover'd the two Islands he called *Falkland's Isles*, lying about 120 Leagues to the Eastwards of the *Patagon Coast*, about the Lat. of 51½. This Capt. *Strong* had a quick Passage from the Island of *Trinadada* (in 20½ South) to the *Magellan Straights*; and in this Journal, which was very well kept, I found that Cape *Virgin* was, by his Account, 45 Degrees of Longitude more Westerly than that Island, whose Longitude I know to be just 30 Degrees from *London*: that is in all 75 Gr.

From these concurrent Testimonies, wanting better, I adventured to fix the Longitude of this Coast as I have done; and I can by no means grant an Error of 10 Degrees to be possible in it, though perhaps it may need some smaller Correction. I will however readily grant, that those that go thither from *Europe*, shall find the Land more Easterly than is here express'd, by reason of a constant Current setting to the Westward near the Equator, where Ships are many times long detained by Calms, whilst the Stream carries them along with it; which thing befalls all Ships bound to any Part of the East Coast of the *South America*.

# PHILOSOPHICAL TRANSACTIONS.

---

For the Months of *January* and *February*, 171 $\frac{1}{2}$ .

---

## The CONTENTS.

- I. **O**bservationes quædam accurate insignis Cometa sub finem anni 1680 visi, Coburgi Saxoniae à Domino Gottfried Kirch habitæ; decimo tertio die antequam à quoquam alio observatus sit.
- II. An Account of the Book entituled *Commercium Epistolicum Collinii & aliorum, De Analyfi promota*; published by order of the Royal-Society, in relation to the Dispute between Mr. Leibnitz and Dr. Keill, about the Right of Invention of the Method of Fluxions, by some call'd the Differential Method.

---

I. *Observationes quædam accuratæ insignis Cometæ sub finem anni 1680 visi, Coburgi Saxonix a Domino Gottfried Kirch habitæ; decimo tertio die antequam a quoquam alio observatus sit.*

**C**OMETA ille qui anno exeunte 1680 visus est, plurimis de causis præcipuus merito habendus est; tam ob Cursum ejus quadrimestrem, quo novem integra Signa percurrit; quam ob immensam Caudæ magnitudinem & clâritatem: maxime vero ob insignem Orbitæ Curvitatē, cujus ope tandem patefacta est Cometarum Theoria. Nam dum Astronomi omni adhibita diligentia motum ejus observationibus definiendo desudarunt, conatus eorum secundavit D. Newtoni in Geometricis vis pene divina, qui primus mortaliū Cometæ Orbes Parabolicis maxime affines describere probavit, ac datis tribus locis accurate observatis eosdem construere docuit, remque hujusce Cometæ exemplo illustravit: id quod sub finem *Lib. III. Principiorum Philosophiæ* videre est.

Accidit autem, nescio quo fato, ut Cometa hic (quem vespertinum tantopere profecuti sunt Cælispecies) antequam Solem attigerat matutinus, nec *Parisiis* neque *Grenovici* ne semel quidem observatus sit: quique eum viderunt & observarunt, incongrua & inter se pignantia, ac pro rei subtilitate parum idonea prodidere: neque ante *Novemb. 17.* mane a quopiam Observatorum visus est. Unde factum ut Orbitæ pars illa, qua ad Solem descendit Cometa, paulo incertius definiri potuit. Bona autem fortuna nuper incidimus in Librum meritissimi Astronomi Domini *Gottfried Kirch, Germani*, anno 1681 *Noribergæ* impressi, cui titulus *Neue Himmls Zeitung*, hoc est *Novus Nuncius cælestis*; ubi auctor diligentissimus nobis exponit, quo casu ductus Cometam hunc nondum adnata Cauda obscurum, ac vix nudis oculis conspicuum detexer-

detexerit; dum scilicet Lunam & Martem ei vicinum observaturiens circumlustraret, die *Novemb. 4. S. V.* mane, idque *Coburgi Saxonia*, quod oppidum XI. Grad. *Londino* orientalius est, sub altitudine poli  $50^{\circ} 20'$  circiter. Excitatus autem, ut ait, rumoribus Cometæ in *Germania* visi, vultu in Orientem verso pernoctavit, ut cœlo tum forte perquam sereno, si quid novi oriretur, situm ejus notaret. Lunâ vero jam ad stellam aliquam *Tychoni* incognitam applicatâ, (sed quæ in Catalogo *Flamsteedii Britannico* habetur, estque numero 44<sup>ta</sup> *Leonis*) voluit dictæ stellæ locum ex circumvicinis Fixis determinare; dumque Tubum trium graduum capacem hinc inde circumrotat, incidit in Luculam quandam nebulosam, speciem insolitam præ se ferentem, quamque vel novum Cometam esse, vel Stellam nebulosam ad instar ejus quæ in *Cingulo Andromedæ* est, statim conclusit.

Primo autem Cometam vidit, Hora 4<sup>ta</sup> matutinâ, paulo altiore duabus stellulis Telescopicis, quæ in *Figura I.* literis *a* & *e* signantur, cum quibus tamen Hora 6<sup>ta</sup> visus est in lineâ accurate rectâ; unde constabat eum moveri, idque motu directo. Inter horas vero 5. & 6. Tubo decempedali Phænomemon hoc contemplatus est, viditque duas alias stellulas contiguas prioribus minores, literisque *e* & *d* notatas, & supra has tertiam *g*. Erat autem distantia Cometæ ab *e* paulo minor quam ab *a*, major vero distantia *d e*. 6<sup>h</sup>. 38' distantia Cometæ ab *e* dupla erat intervalli inter ipsas *d e*, ac linea *d e* producta reliquit Cometam\* infra se, sic tamen ut marginem ejus superiorem attingeret. 6<sup>h</sup>. 45'. Cometa jam sensibilibiter remotior erat ab *e* quam ab *a*, distabatque ab *a* paulo plus quam dimidio distantia stellarum *a* & *g*.

Notandum vero est Horologium totis 14 minutis cœlum anticipasse, uti ex altitudinibus *Cordis Leonis* tum captis paruit.

Nobilis sane est hæc observatio, adeoque Stellarum Cometæ tunc adjacentium loca non una methodo perquisivimus, exercitatissimam manum suam & instrumenta perelegantia

\* Tubo scilicet objecta invertente.

præbente Reverendo Viro D. Jacobo Pound, R. Soc. Sodali. Unde constabat stellulas illas tum temporis infra scriptos habuisse situs, nempe

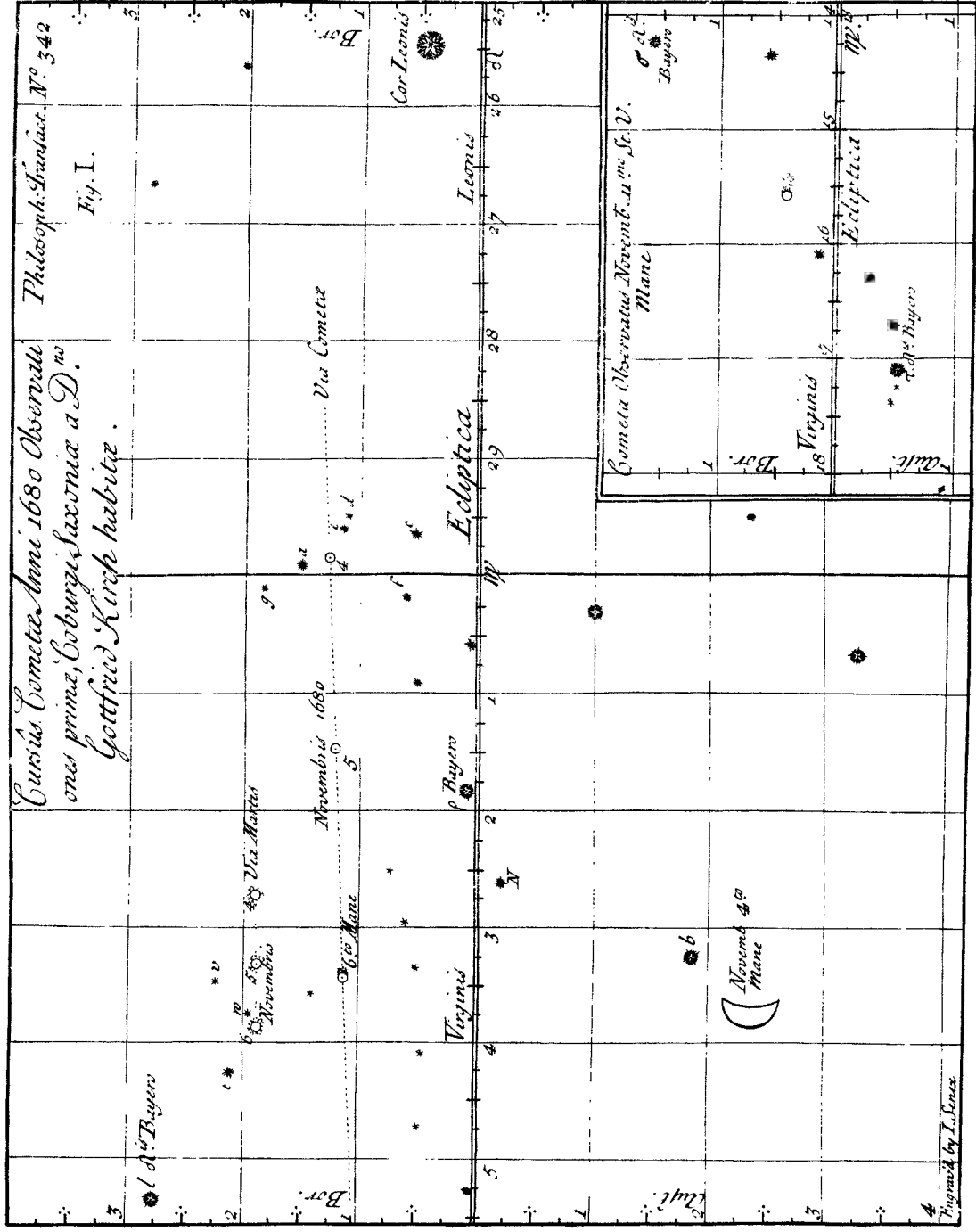
	Long.	Lat.
<i>a</i>	$\Omega$ 29°. 44'. 20	1. 29. 20 Bor.
<i>d</i>	29. 27. 20	1. 8. 00
<i>e</i>	29. 34. 30	1. 10. 45

Circulus autem maximus per *a* & *c* ductus, deprehensus est: per *Ultimam Caudæ Ursæ majoris* transire, adeoque angulum cum circulo Longitudinis ad *a* esse  $15^{\circ} 36' \frac{1}{2}$ . Cumque distantia Cometæ ab *a* versus *c* paulo major fuerat dimidio distantia *a g*, (quam Tubo sedecim pedum & Micrometro deprehendimus  $21 \frac{2}{3}$  min.) ponamus eam fuisse duodecim minutorum; & ex datis proveniet Cometæ locus  $\Omega$   $29^{\circ} 51'$  cum Lat. Borea  $1^{\circ} 17' \frac{3}{4}$ . Hora scilicet Horologii  $6^{ta}$ , sed *Londini*  $5^h 2'$  Temp. Appar.

Deinde *Novemb.* 6. mane,  $4^h 42'$ , Tubo bipedali deprehendit Comeram omnino in linea recta inter *Martem* & Stellulam *N*; quæ quidem in *Catalogo Britannico*  $45^{ta}$  Leonis est, & tunc erat in  $\pi$   $2^{\circ} 42'$  cum Lat. Aust.  $0^{\circ} 16' \frac{1}{2}$ . *Mars* autem tum temporis habuit (ex collatis observationibus paulo antea & post factis)  $\pi$   $3^{\circ} 46' \frac{1}{2}$  cum Lat. Bor.  $1^{\circ} 56'$ . Unde, ob datam ejus viam, Cometa occupavit  $\pi$   $3^{\circ} 23'$  cum Lat. Bor.  $1^{\circ} 6'$ . *Londini* Temp. App.  $3^h 58'$  mane.

*Novembris* quoque  $11^{mo}$   $5^h 15'$  mane, Cometa æqualiter distabat à Stellis Leonis  $\sigma$  &  $\tau$  *Bayero*, nondum vero attigit rectam easdem jungentem, sed parum abfuit ab ea. In *Catalogo Britannico*  $\sigma$  tunc habuit  $\pi$   $14^{\circ} 15'$  cum Lat. Bor.  $1^{\circ} 41'$  ferè,  $\tau$  vero  $\pi$   $17^{\circ} 3' \frac{1}{2}$  cum Lat. Aust.  $0^{\circ} 34'$ . Proinde Cometæ Latitudo paulo minor erat medio inter illas, nempe quam  $0^{\circ} 33' \frac{1}{2}$  Bor. ac Longitudo quam  $\pi$   $15^{\circ} 39'$ . Sed huic non utique fidendum, cum pendeat ab æstimata æqualitate distantiarum, quæ res lubrica est. Cauda autem jam cœpta non nisi dimidio gradu longa Tubo decempedali visa est.

Qui plura cupit adeat Librum ipsum *Germanicè* editum.



---

II. *An Account of the Book entituled* *Commercium Epistolicum Collinii & aliorum, De Analyfi promota*; published by order of the Royal-Society, in relation to the Dispute between Mr. Leibnitz and Dr. Keill, about the Right of Invention of the Method of Fluxions, by some call'd the Differential Method.

SEVERAL Accounts having been published abroad of this *Commercium*, all of them very imperfect: It has been thought fit to publish the Account which follows.

This *Commercium* is composed of several ancient Letters and Papers, put together in order of Time, and either copied or translated into Latin from such Originals as are described in the Title of every Letter and Paper; a numerous Committee of the Royal-Society being appointed to examine the Sincerity of the Originals, and compare therewith the Copies taken from them. It relates to a general Method of resolving finite Equations into infinite ones, and applying these Equations, both finite and infinite, to the Solution of Problems by the Method of Fluxions and Moments. We will first give an Account of that Part of the Method which consists in resolving finite Equations into infinite ones, and squaring curvilinear Figures thereby. By Infinite Equations are meant such as involve a Series of Terms converging or approaching the Truth nearer and nearer *in infinitum*, so as at length to differ from the Truth less than by any given Quantity, and if continued *in infinitum*, to leave no Difference.

Dr. Wallis in his *Opus Arithmeticum* published A. C. 1657: Cap. 33. Prop. 68. reduced the Fraction  $\frac{A}{1-R}$  by perpetual Division into the Series  $A + AR + AR^2 + AR^3 + AR^4 + \&c.$

Viscount Brounker squared the Hyperbola by this Series  $\frac{1}{1 \times 2} + \frac{1}{3 \times 4} + \frac{1}{5 \times 6} + \frac{1}{7 \times 8} + \&c.$  that is by this,  $1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \frac{1}{5} - \frac{1}{6} + \frac{1}{7} - \frac{1}{8} + \&c.$  conjoyning every two Terms into one. And the Quadrature was published in the *Philosophical Transactions* for April 1668.

Mr. Mercator soon after published a Demonstration of this Quadrature by the Division of Dr. Wallis; and soon after that Mr. James Gregory published a Geometrical Demonstration thereof. And these Books were a few Months after sent by Mr. John Collins to Dr. Barrow at Cambridge, and by Dr. Barrow communicated to Mr. Newton (now Sir Isaac Newton) in June 1669. Whereupon Dr Barrow mutually sent to Mr. Collins a Tract of Mr. Newton's entituled *Analysis per equationes numero terminorum infinitas*. And this is the first Piece published in the *Commercium*, and contains a general Method of doing in all Figures, what my Lord Brounker and Mr. Mercator did in the Hyperbola alone. Mr. Mercator lived above ten Years longer without proceeding further than to the single Quadrature of the Hyperbola. The Progress made by Mr. Newton shews that he wanted not Mr. Mercator's Assistance. However, for avoiding Disputes, he supposes that my Lord Brounker invented, and Mr. Mercator demonstrated, the Series for the Hyperbola some Years before they published it, and, by consequence, before he found his general Method.

The aforesaid Treatise of *Analysis* Mr. Newton, in his Letter to Mr. Oldenburgh, dated Octob. 24. 1676. mentions in the following Manner. *Eo ipso tempore quo Mercatoris Logarithmotechnia prodiit, communicatum est per amicum D. Barrow (tunc Matheseos Professore Cantab) cum D. Collinio Compendium quoddam harum Serierum, in quo significaveram Areas & Longitudines Curvarum omnium, & Solidorum superficies & contenta ex datis.*



*datis rectis ; & vice versa ex his datis rectas determinari posse : & methodum indicatam illustraveram diversis seriebus.* Mr. Collins in the Years 1669, 1670, 1671 and 1672 gave notice of this Compendium to Mr. James Gregory in Scotland, Mr. Bertet and Mr. Vernon then at Paris, Mr. Alphonsus Borelli in Italy, and Mr. Strode, Mr. Townsend, Mr. Oldenburgh, Mr. Dary and others in England, as appears by his Letters. And Mr. Oldenburg in a Letter, dated Sept. 14. 1669. and entred in the Letter-Book of the Royal-Society, gave notice of it to Mr. Francis Slufius at Liege, and cited several Sentences out of it. And particularly Mr. Collins in a Letter to Mr. James Gregory dated Novemb. 25. 1669. spake thus of the Method contained in it. *Barrovius Provinciam suam publicè prælegendi remisit cuidam nomine Newtono Cantabrigiensi, cujus tanquam viri acutissimo ingenio præditi in Præfatione Prælectionum Opticarum, meminit : quippe antequam ederetur Mercatoris Logarithmotechnia, eandem methodum adinvenerat, eamque ad omnes Curvas generaliter & ad Circulum diversimode applicarat.* And in a Letter to Mr. David Gregory dated August 11. 1676. he mentions it in this manner. *Paucos post menses quam editi sunt hi Libri [viz. Mercatoris Logarithmotechnia & Exercitationes Geometricæ Gregorii] missi sunt ad Barrovium Cantabrigiæ. Ille autem responsum dedit hanc infinitarum Serierum Doctrinam à Newtono biennium ante excogitatam fuisse quam ederetur Mercatoris Logarithmotechnia & generaliter omnibus figuris applicatam, simulque transmissit D. Newtoni opus manuscriptum.* The last of the said two Books came out towards the End of the Year 1668, and Dr. Barrow sent the said Compendium to Mr. Collins in July following, as appears by three of Dr. Barrow's Letters. And in a Letter to Mr. Strode, dated July 26. 1672, Mr. Collins wrote thus of it. *Exemplar ejus [Logarithmotechniæ] missi Barrovio Cantabrigiam, qui quasdam Newtoni chartas extemplo remisit : E quibus & aliis quæ prius ab authore cum Barrovio communicata fuerant, patet illam methodum à dicto Newtono aliquot annis antea excogitatam & modo univer-*

*fali applicatam fuisse : Ita ut ejus opz, in quavis Figura Curvilinea propofita, qua una vel pluribus proprietatibus definitur, Quadratura vel Area dictæ figuræ, accurata fi poffibile fit, fin minus infinite verò propinqua, Evolutio vel longitudo Lineæ Curvæ, Centrum gravitatis figuræ, Solida ejus rotatione genita & eorum superficies ; fine ulla radicum extractione obtineri queant. Postquam intellexerat D. Gregorius hanc methodum à D. Mercatore in Logarithmotechnia usurpatam & Hyperbola quadranda adhibitam, quamque adauxerat ipse Gregorius, jam universalem redditam esse, omnibusque figuris applicatam; acri studio eandem acquisivit multumque in ea enodanda disudavit. Uterque D. Newtonus & Gregorius in animo habet hanc methodum exornare : D. Gregorius autem D. Newtonum primum ejus inventorem anticipare hand integrum ducit. And in another Letter written to Mr. Oldenburgh to be communicated to Mr. Leibnitz, and dated June 14 1676. Mr. Collins adds: Hujus autem methodi ea est præstantia ut cum tam late pateat ad nullam hæreat difficultatem. Gregorium autem aliosque in ea fuisse opinione arbitror, ut quicquid uspiam antea de hac re innotuit, quasi dubia diluculi lux fuit si cum meridiana claritate conferatur.*

This Tract was first printed by Mr William Jones, being found by him among the Papers and in the Hand-writing of Mr. John Collins, and collated with the Original which he afterwards borrowed of Mr. Newton. It contains the above-mention'd general Method of *Analysis*, teaching how to resolve finite Equations into infinite ones, and how by the method of Moments to apply Equations both finite and infinite to the Solution of all Problems. It begins where Dr. Wallis left off, and founds the method of Quadratures upon three Rules.

Dr. Wallis published his *Arithmetica infinitorum* in the Year 1655, and by the 59th Proposition of that Book, if the *Abscissa* of any curvilinear Figure be called  $x$ , and  $m$  and  $n$  be Numbers, and the Ordinates erected at right Angles be  $x^{\frac{m}{n}}$ , the Area of the Figure shall be  $\frac{n}{m+n} x^{\frac{m+n}{n}}$ . And this is assumed by

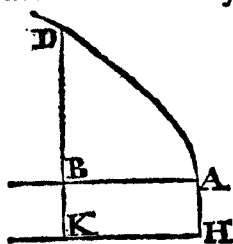
by Mr. *Newton* as the first Rule upon which he founds his Quadrature of Curves. Dr. *Wallis* demonstrated this Proposition by Steps in many particular Propositions, and then collected all the Propositions into One by a Table of the Cases. Mr. *Newton* reduced all the Cases into One, by a Dignity with an indefinite Index, and at the End of his Compendium demonstrated it at once by his method of Moments, he being the first who introduced indefinite Indices of Dignities into the Operations of *Analysis*.

By the 108th Proposition of the said *Arithmetica Infinitorum*, and by several other Propositions which follow it; if the Ordinate be composed of two or more Ordinates taken with their Signes + and —, the Area shall be compos'd of two or more Areas taken with their Signes + and — respectively. And this is assumed by Mr. *Newton* as the second Rule upon which he founds his Method of Quadratures.

And the third Rule is to reduce Fractions and Radicals, and the affected Roots of Equations into converging Series, when the Quadrature does not otherwise succeed; and by the first and second Rules to square the Figures, whose Ordinates are the single Terms of the Series. Mr. *Newton*, in his Letter to Mr. *Oldenburgh* dated June 13. 1676. and communicated to Mr. *Leibnitz*, taught how to reduce any Dignity of any Binominal into a converging Series, and how by that Series to square the Curve, whose Ordinate is that Dignity. And being desired by Mr. *Leibnitz* to explain the Original of this Theoreme, he replied in his Letter dated Octob. 24. 1676, that a little before the Plague (which raged in *London* in the Year 1665) upon reading the *Arithmetica Infinitorum* of Dr. *Wallis*, and considering how to interpolate the Series  $x$ ,  $x - \frac{1}{3}x^3$ ,  $x - \frac{2}{3}x^3 + \frac{1}{5}x^5$ ,  $x - \frac{2}{3}x^3 + \frac{2}{5}x^5 - \frac{1}{7}x^7$ , &c. he found the Area of a Circle to be  $x - \frac{\frac{1}{2}x^3}{3} - \frac{\frac{1}{8}x^5}{5} - \frac{\frac{1}{16}x^7}{7} - \frac{\frac{5}{128}x^9}{9} - \&c.$  And by pursuing the Method of Interpolati-

on he found the Theoreme abovemention'd, and by means of this Theoreme he found the Reduction of Fractions and Surds into converging Series, by Division and Extraction of Roots; and then proceeded to the Extraction of affected Roots. And these Reductions are his third Rule.

When Mr. *Newton* had in this Compendium explained these three Rules, and illustrated them with various Examples, he laid down the Idea of deducing the Area from the Ordinate, by considering the Area as a Quantity, growing or increasing by continual Flux, in proportion to the Length of the Ordinate, supposing the Abscissa to increase uniformly in proportion to Time. And from the Moments of Time he gave the Name of Moments to the momentaneous Increases, or infinitely small Parts of the Abscissa and Area, generated in Moments of Time. The Moment of a Line he called a Point, in the Sense of *Cavallerius*, tho' it be not a geometrical Point, but a Line infinitely short, and the Moment of an Area or Superficies he called a Line, in the Sense of *Cavallerius*, tho' it be not a geometrical Line, but a Superficies infinitely narrow. And when he consider'd the Ordinate as the Moment of the Area, he understood by it the Rectangles under the geometrical Ordinate and a Moment of the Abscissa, tho' that Moment be not always expressed. *Sit ABD*, saith he, *Curva*



*quevis, & AHKB rectangulum cujus latus AH vel KB est unitas. Et cogita rectam DBK uniformiter ab AH motam areas ABD & AK describere; & quod [recta] BK (1) sit momentum quo [area] AK (x), & [recta] BD (y) momentum quo [area curvilinea] ABD gradatim augetur; & quod ex momento BD perpetim dato possis, per preedentes [tres] Regulas, aream ABD ipso descriptam investigare, sive cum area AK (x) momento 1 descripta conferre.* This is his Idea of the Work in squaring of Curves, and how he applies this to other Problems, he expresses in the next Words. *Jam qua ratione*, saith he, *superficies ABD ex momento suo perpetim*

*petim dato per præcedentes [tres] Regulas elicatur, eâdem qualibet alia quantitas ex momento suo sic dato elicetur. Exemplo res fiet clarior.* And after some Examples he adds his Method of Regression from the Area, Arc, or Solid Content, to the Abscissa; and shews how the same Method extends to Mechanical Curves, for determining their Ordinates, Tangents, Areas, Lengths, &c. And that by assuming any Equation expressing the Relation between the Area and Abscissa of a Curve, you may find the Ordinate by this Method. And this is the Foundation of the Method of Fluxions and Moments, which Mr. Newton in his Letter dated Octob. 24, 1676 comprehended in this Sentence. *Data æquatione quocunque fluentes quantitates involvente, invenire Fluxiones; & vice versa.*

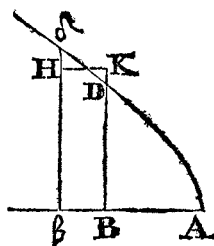
In this Compendium Mr. Newton represents the uniform Fluxion of Time, or of any Exponent of Time by an Unit; the Moment of Time or of its Exponent by the Letter *o*; the Fluxions of other Quantities by any other Symbols; the Moments of those Quantities by the Rectangles under those Symbols and the Letter *o*; and the Area of a Curve by the Ordinate inclosed in a Square, the Area being put for a Fluent and the Ordinate for its Fluxion. When he is demonstrating any Proposition he uses the Letter *o* for a finite Moment of Time, or of its Exponent, or of any Quantity flowing uniformly, and performs the whole Calculation by the Geometry of the Ancients in finite Figures or Schemes without any Approximation: and so soon as the Calculation is at an End, and the Equation is reduced, he supposes that the Moment *o* decreases in infinitum and vanishes. But when he is not demonstrating but only investigating a Proposition, for making Dispatch he supposes the Moment *o* to be infinitely little, and forbears to write it down, and uses all manner of Approximations which he conceives will produce no Error in the Conclusion. An Example of the first kind you have in the End of this Compendium, in demonstrating the first of the three Rules laid down in the Beginning of the Book.

Examples of the second kind you have in the same Compendium, in finding the Length of Curve Lines *p.* 15. and in finding the Ordinates, Areas and Lengths of Mechanical Curves *p.* 18. 19. And he tells you, that by the same Method, Tangents may be drawn to mechanical Curves *p.* 19. And in his Letter of *Decemb.* 10. 1672. he adds, that Problems about the Curvature of Curves Geometrical or Mechanical are resolv'd by the same Method. Whence its manifest, that he had then extended the Method to the second and third Moments. For when the Areas of Curves are considered as Fluents (as is usual in this *Analysis*) the Ordinates express the first Fluxions, the Tangents are given by the second Fluxions, and the Curvatures by the third, And even in this *Analysis* *p.* 16. where Mr. Newton saith, *Momentum est superficies cum de solidis, & Linea cum de superficiebus, & Punctum cum de lineis agitur*, it is all one as if he had said, that when Solids are considered as Fluents, their Moments are Superficies, and the Moments of those Moments (or second Moments) are Lines, and the Moments of those Moments (or third Moments) are Points, in the Sense of *Cavallerius*. And in his *Principia Philosophiæ*, where he frequently considers Lines as Fluents described by Points, whose Velocities increase or decrease, the Velocities are the first Fluxions, and their Increase the second. And the Probleme, *Data æquatione fluentes quantitates involvente fluxiones invenire & vice versa*, extends to all the Fluxions, as is manifest by the Examples of the Solution thereof, published by Dr. Wallis *Tom.* 2. *p.* 391, 392, 396. And in *Lib.* II. *Princip. Prop.* XIV. he calls the second Difference the Difference of Moments.

Now that you may know what kind of Calculation Mr. Newton used in, or before the Year 1669. when he wrote this Compendium of his *Analysis*, I will here set down his Demonstration of the first Rule abovementioned. *Sit*

*Curva*

Sit Curvæ alicujus AD  $\delta$  Basis AB = x, perpendiculariter applicata BD = y, & area ABD = z, ut prius. Item sit B $\beta$  = o, BK = v, & Rectangulum B $\beta$ HK (o v) æquale spatio B $\beta$  $\delta$ D. Est ergo A $\beta$  = x + o, & A $\delta$  $\beta$  = z + o v, His præmissis, ex relatione inter x & z ad arbitrium assumpta, quero y ut sequitur.



Pro lubitu sumatur [æquatio]  $\frac{2}{3} x^{\frac{3}{2}} = z$ , sive  $\frac{2}{3} x^{\frac{3}{2}} = z z$ . Tum x + o (A $\beta$ ) pro x, & z + o v (A $\delta$  $\beta$ ) pro z substitutis, prodibit  $\frac{2}{3}$  in  $x^{\frac{3}{2}} + 3 x^{\frac{1}{2}} o + 3 x o^{\frac{3}{2}} + o^{\frac{3}{2}} =$  (ex natura Curvæ)  $z^2 + 2 z o v + o^2 v^2$ . Et sublati  $\frac{2}{3} x^{\frac{3}{2}}$  & z z æqualibus, reliquisque per o divisus, restat  $\frac{2}{3}$  in  $3 x^{\frac{1}{2}} + 3 x o + o^2 = 2 z v + o v^2$ . Si jam supponamus B $\beta$  in infinitum diminui & evanescere, sive o esse nihil, erunt v & y æquales, & termini per o multiplicati evanescent; ideoque restabit  $\frac{2}{3} \times 3 x x = 2 z v$ , sive  $\frac{2}{3} x x (= z y) = \frac{2}{3} x^{\frac{3}{2}} y$ , sive  $x^{\frac{1}{2}} (= \frac{x^2}{x^{\frac{3}{2}}}) = y$ . Quare è contra, si  $x^{\frac{1}{2}} = y$ , erit  $\frac{2}{3} x^{\frac{3}{2}} = z$ .

Vel generaliter, Si  $\frac{n}{m+n} \times a x^{\frac{m+n}{n}} = z$ ; sive ponendo  $\frac{na}{m+n} = c$ , & m + n = p, Si  $c x^{\frac{p}{n}} = z$ , sive  $c^n x^p = z^n$ : Tum x + o pro x, & z + o y sive (quod perinde est) z + o y pro z substitutis, prodit  $c^n$  in  $x^p + p o x^{p-1}$  &c. =  $z^n + n o y z^{n-1}$  &c. reliquis nempe [Serierum] terminis, qui tandem evanescent, omissis. Jam sublati  $c^n x^p$  &  $z^n$  æqualibus, reliquisque per o divisus, restat  $c^n p x^{p-1} = n y z^{n-1} (= \frac{n y z^n}{z} = \frac{n y c^n x^p}{c x^{\frac{p}{n}}})$  sive dividendo per  $c^n x^p$ , erit  $p x^{-1} = \frac{n y}{c x^{\frac{p}{n}}}$  sive  $p c x^{\frac{p-n}{n}} = n y$ ; vel re-

stituendo  $\frac{na}{m+n}$  pro c & m + n pro p, hoc est m pro p - n, & na

*pro p c, fiet a x<sup>m</sup> = y. Quare è contra, si ax<sup>m</sup> = y erit*  $\frac{n}{m+n} a x^{\frac{m+n}{n}}$   
 $= z$  Q. E. D.

By the same way of working the second Rule may be also demonstrated. And if any Equation whatever be assumed expressing the Relation between the Abscissa and Area of a Curve, the Ordinate may be found in the same manner, as is mentioned in the next Words of the *Analysis*. And if this Ordinate drawn into an Unit be put for the Area of a new Curve, the Ordinate of this new Curve may be found by the same Method: And so on perpetually. And these Ordinates represent the first, second, third, fourth and following Fluxions of the first Area.

This was Mr. *Newton's* Way of working in those Days, when he wrote this Compendium of his *Analysis*. And the same Way of working he used in his Book of Quadratures, and still uses to this Day.

Among the Examples with which he illustrates the Method of Series and Moments set down in this Compendium, are these. Let the Radius of a Circle be 1, and the Arc  $z$ , and the Sine  $x$ , the Equations for finding the Arc whose Sine is given, and the Sine whose Arc is given, will be

$$z = x + \frac{1}{6}x^3 + \frac{3}{40}x^5 + \frac{5}{112}x^7 + \frac{35}{1152}x^9 + \&c.$$

$$x = z - \frac{1}{6}z^3 + \frac{1}{120}z^5 - \frac{1}{5040}z^7 + \frac{1}{362880}z^9 - \&c.$$

Mr. *Collins* gave Mr. *Gregory* notice of this Method in Autumn 1669, and Mr. *Gregory*, by the Help of one of Mr. *Newton's* Series, after a Year's Study, found the Method in December 1670; and two Months after, in a Letter dated Feb. 15. 1671. sent several Theorems, found thereby, to Mr. *Collins*, with leave to communicate them freely. And Mr. *Collins* was very free in communicating what he had received both from Mr. *Newton* and from Mr. *Gregory*, as appears by his Letters printed in the *Commercium*. Amongst the Series which Mr. *Gregory* sent in the said Letter, were these



these two. Let the Radius of a Circle be  $r$ , the Arc  $a$ , and the Tangent  $t$ , the Equations for finding the Arc whose Tangent is given, and the Tangent whose Arc is given, will be these.

$$a = t - \frac{t^3}{3r^2} + \frac{t^5}{5r^4} - \frac{t^7}{7r^6} + \frac{t^9}{9r^8} - \&c.$$

$$t = a + \frac{a^3}{3r^2} + \frac{2a^5}{15r^4} + \frac{17a^7}{315r^6} + \frac{61a^9}{2835r^8} + \&c.$$

In this Year (1671) Mr. *Leibnitz* published two Tracts at *London*, the One dedicated to the Royal-Society, the Other dedicated to the Academy of Sciences at *Paris*; and in the Dedication of the First he mentioned his Correspondence with Mr. *Oldenburgh*.

In February 167 $\frac{1}{2}$  meeting Dr. *Pell* at Mr. *Boyle's*, he pretended to the differential Method of *Monton*. And notwithstanding that he was shewn by Dr. *Pell* that it was *Monton's* Method, he persisted in maintaining it to be his own Invention, by reason that he had found it himself without knowing what *Monton* had done before, and had much improved it.

When one of Mr. *Newton's* Series was sent to Mr. *Gregory*, he tried to deduce it from his own Series combined together, as he mentions in his Letter dated December 19. 1670. And by some such Method Mr. *Leibnitz*, before he left *London*, seems to have found the Sum of a Series of Fractions decreasing in *Infinitum*, whose Numerator is a given Number and Denominators are triangular or pyramidal or triangulo-triangular Numbers, &c. See the Mystery! From the Series  $\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \&c.$  subduct all the Terms but the first (*viz*  $\frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \&c.$ ) and there will remain  $1 = 1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \frac{1}{5} - \frac{1}{6} + \frac{1}{7} - \frac{1}{8} + \frac{1}{9} - \frac{1}{10} + \frac{1}{11} - \frac{1}{12} + \frac{1}{13} - \frac{1}{14} + \frac{1}{15} - \frac{1}{16} + \frac{1}{17} - \frac{1}{18} + \frac{1}{19} - \frac{1}{20} + \&c.$  And from this Series take all the Terms but the first, and there will remain  $\frac{1}{2} = \frac{2}{1 \times 2 \times 3} + \frac{2}{2 \times 3 \times 4} + \frac{2}{3 \times 4 \times 5} + \frac{2}{4 \times 5 \times 6} + \&c.$  And from the first Series take all the Terms but the two first, and there will remain  $\frac{2}{3} = \frac{2}{1 \times 3} + \frac{2}{2 \times 4} + \frac{2}{3 \times 5} + \frac{2}{4 \times 6} + \&c.$

In the End of *February* or beginning of *March* 167 $\frac{2}{3}$ . Mr. *Leibnitz* went from *London* to *Paris*, and continuing his Correspondence with Mr *Oldenburg* and Mr. *Collin*, wrote in *July* 1674. that he had a wonderful Theoreme, which gave the Area of a Circle or any Sector thereof exactly in a Series of rational Numbers; and in *October* following, that he had found the Circumference of a Circle in a Series of very simple Numbers, and that by the same Method (so he calls the said Theoreme) any Arc whose Sine was given might be found in a like Series, though the Proportion to the whole Circumference be not known. His Theoreme therefore was for finding any Sector or Arc whose Sine was given. If the Proportion of the Arc to the whole Circumference was not known, the Theoreme or Method gave him only the Arc; if it was known it gave him also the whole Circumference: and therefore it was the first of Mr. *Newton*'s two Theoremes above-mention'd. But the Demonstration of this Theoreme Mr *Leibnitz* wanted. For in his Letter of *May* 12. 1676. he desired Mr. *Oldenburg* to procure the Demonstration from Mr *Collins*, meaning the Method by which Mr. *Newton* had invented it.

In a Letter compos'd by Mr. *Collins* and dated *April* 15. 1675. Mr. *Oldenburg* sent to Mr. *Leibnitz* Eight of Mr. *Newton*'s and Mr. *Gregory*'s Series, amongst which were Mr. *Newton*'s two Series above-mention'd for finding the Arc whose Sine is given, and the Sine whose Arc is given; and Mr. *Gregory*'s two Series above mentioned for finding the Arc whose Tangent is given, and the Tangent whose Arc is given. And Mr. *Leibnitz* in his Answer, dated *May* 20. 1675. acknowledged the Receipt of this Letter in these Words. *Literas tuas multa fruge Algebraica refertas accepi, pro quibus tibi & doctissimo Collinio gratias ago. Cum nunc præter ordinarias curas Mechanicis imprimis negotiis distrabar, non potui examinare Series quas misistis ac cum meis comparare. Ubi fecero perscribam tibi sententiam meam: nam aliquot jam anni sunt quod inveni meas via quadam sic satis singulari.* But

But yet Mr. *Leibnitz* never took any further notice of his having received these Series, nor how his own differed from them, nor ever produced any other Series then those which he received from Mr. *Oldenburgh*, or numeral Series deduced from them in particular Cases. And what he did with Mr. *Gregory's* Series for finding the Arc whose Tangent is given, he has told us in the *Acta Eruditorum mensis Aprilis 1691. pag. 178.* Jam anno 1675, saith he, *compositum habebam opusculum Quadraturæ Arithmeticæ ab amicis ab illo tempore lectum, &c.* By a Theoreme for transmuting of Figures, like those of Dr. *Barrow* and Mr. *Gregory*, he had now found a Demonstration of this Series, and this was the Subject of his *Opusculum*. But he still wanted a Demonstration of the rest: and meeting with a Pretence to ask for what he wanted, he wrote to Mr. *Oldenburg* the following Letter, dated at *Paris May 12. 1676.*

*Cum Georgius Mohr Danus nobis attulerit communicatam sibi à Doctissimo Collinio vestro expressionem rationis inter arcum & sinum per infinitas Series sequentes; posito sinu x, arcu z, radio 1,*

$$z = x + \frac{1}{6}x^3 + \frac{3}{40}x^5 + \frac{5}{112}x^7 + \frac{35}{1152}x^9 + \text{\&c.}$$

$$x = z - \frac{1}{6}z^3 + \frac{1}{120}z^5 - \frac{1}{5040}z^7 + \frac{1}{362880}z^9 - \text{\&c.}$$

*Hæc, IN QUAM, cum nobis attulerit ille, quæ mihi valde ingeniosa videntur, & posterior imprimis Series elegantiam quandam singularem habeat: ideo rem gratam mihi feceris, Vir clarissime, si demonstrationem transmiseris. Habebis vicissim mea ab his longe diversa circa hanc rem meditata, de quibus jam aliquot abhinc annis ad te perscripsisse credo, demonstratione tamen non addita, quam nunc polio. Oro ut Clarissimo Collinio multam a me salutem dicas: is facile tibi materiam suppeditabit satisfaciendi d'fiderio meo.* Here, by the Word *IN QUAM*, one would think that he had never seen these two Series before, and that his *diversa circa hanc rem meditata* were something else than one of the Series which he had received from

Mr. *Oldenburgh* the Year before, and a Demonstration thereof which he was now polishing, to make the Present an acceptable Recompence for Mr. *Newton*'s Method.

Upon the Receipt of this Letter Mr. *Oldenburg* and Mr. *Collins* wrote pressingly to Mr. *Newton*, desiring that he himself would describe his own Method, to be communicated to Mr. *Leibnitz*. Whereupon Mr. *Newton* wrote his Letter, dated *June 13. 1676*, describing therein the Method of Series, as he had done before in the Compendium above-mentioned; but with this Difference: Here he described at large the Reduction of the Dignity of a Binomial into a Series, and only touched upon the Reduction by Division and Extraction of affected Roots: There he described at large the Reduction of Fractions and Radicals into Series by Division and Extraction of Roots, and only set down the two first Terms of the Series into which the Dignity of a Binomial might be reduced. And among the Examples in this Letter, there were Series for finding the Number whose Logarithm is given, and for finding the Versed Sine whose Arc is given: This Letter was sent to *Paris, June 26. 1676.* together with a MS. drawn up by Mr. *Collins*, containing Extracts of Mr. *James Gregory*'s Letters.

For Mr. *Gregory* died near the End of the Year 1675; and Mr. *Collins*, at the Request of Mr. *Leibnitz* and some other of the Academy of Sciences, drew up Extracts of his Letters, and the Collection is still extant in the Hand Writing of Mr. *Collins* with this Title; *Extracts of Mr. Gregory's Letters, to be lent to Mr. Leibnitz to peruse, who is desired to return the same to you.* And that they were sent is affirmed by Mr. *Collins* in his Letter to Mr. *David Gregory* the Brother of the Deceased, dated *August 11. 1676.* and appears further by the Answers of Mr. *Leibnitz* and Mr. *Tschurnhause* concerning them.

The Answer of Mr. *Leibnitz* directed to Mr. *Oldenburgh* and dated *August 27. 1676,* begins thus; *Littere tuæ die Julii 26. data plura ac memorabiliora circa rem Analyticam continent quam*

*multa volumina spiffa de his rebus edita. Quare tibi pariter ac clarissimis viris Newtono ac Collinio gratias ago, qui nos participes tot meditationum egregiarum esse voluistis.* And towards the End of the Letter, after he had done with the Contents of Mr. Newton's Letter, he proceeds thus. *Ad alia tuarum Literarum venio quæ doctissimus Collinius communicare gravatus non est. Vellem adiecisset appropinquationis Gregorianæ linearis demonstrationem. Fuit enim his certe studiis promovendis aptissimus.* And the Answer of Mr. Tschurnhause, dated Sept. 1. 1676, after he had done with Mr. Newton's Letter about Series, concludes thus. *Similia porro quæ in hac re præstitit eximius ille Geometra Gregorius memoranda certe sunt. Et quidem optimè famæ ipsius consulendi, qui ipsius relicta Manuscripta luci publicæ ut exponantur operam navabunt.* In the first Part of this Letter, where Mr. Tschurnhause speaks of Mr. Newton's Series, he saith that he looked over them cursorily, to see if he could find the Series of Mr. Leibnitz for squaring the Circle or Hyperbola. If he had searched for it in the Extracts of Gregory's Letters he might have found it in the Letter of Febr. 15. 1671. above-mentioned. For the MS. of those Extracts with that Letter therein is still extant in the Hand-Writing of Mr. Collins.

And tho' Mr. Leibnitz had now received this Series twice from Mr. Oldenburgh, yet in his Letter of August. 27. 1676. he sent it back to him by way of Recompence for Mr. Newton's Method, pretending that he had communicated it to his Friends at Paris three Years before or above; that is, two Years before he received it in Mr. Oldenburgh's Letter of April 15 1675; at which Time he did not know it to be his own, as appears by his Answer of May 20. 1675 above-mentioned. He might receive this Series at London, and communicate it to his Friends at Paris above three Years before he sent it back to Mr. Oldenburgh: but it doth not appear that he had the Demonstration thereof so early. When he found the Demonstration, then he compos'd it in his *Opusculum*, and communicated that also to his Friends; and he himself has

told us that this was in the Year 1675. However, it lies upon him to prove that he had this Series before he received it from Mr. Oldenburgh. For in his Answer to Mr. Oldenburgh he did not know any of the Series then sent him to be his own; and concealed from the Gentlemen at Paris his having received it from Mr. Oldenburgh with several other Series, and his having seen a Copy of the Letter in which Mr. Gregory had sent it to Mr. Collins in the Beginning of the Year 1671.

In the same Letter of August 27. 1676, after Mr. Leibnitz had described his Quadrature of the Circle and Equilateral Hyperbola, he added : *Vicissim ex seriebus regressuum pro Hyperbola hanc inveni. Si sit numerus aliquis unitate minor*  $1 - m$ , *ejusque logarithmus Hyperbolicus* l. *Erit*  $m = \frac{1}{1} - \frac{1^2}{1 \times 2} + \frac{1^3}{1 \times 2 \times 3} - \frac{1^4}{1 \times 2 \times 3 \times 4} + \&c.$  *Si numerus sit major unitate, ut*  $1 + n$ , *tunc pro eo inveniando mihi etiam prodiit Regula quæ in Newtoni Epistola expressa est : scilicet erit*  $n = \frac{1}{1} + \frac{1^2}{1 \times 2} + \frac{1^3}{1 \times 2 \times 3} + \frac{1^4}{1 \times 2 \times 3 \times 4} + \&c.$  — *Quod regressum ex arcibus attinet, incideram ego directe in Regulam quæ ex dato arcu sinum complementi exhibet. Nempe sinus complementi*  $= 1 - \frac{a^2}{1 \times 2} + \frac{a^4}{1 \times 2 \times 3 \times 4} - \&c.$  *Sed postea quoque deprehendi ex ea illam nobis communicatam pro inveni-endo sinu recto, qui est*  $\frac{a}{1} - \frac{a^3}{1 \times 2 \times 3} + \frac{a^5}{1 \times 2 \times 3 \times 4 \times 5} - \&c.$  *posse demonstrari.* Thus Mr. Leibnitz put in his Claim for the Co-invention of these four Series, tho' the Method of finding them was sent him at his own Request, and he did not yet understand it. For in this same Letter of August 27 1676. he desired Mr. Newton to explain it further. His Words are. *Sed desideraverim ut Clarissimus Newtonus nonnulla quoque amplius explicet ; ut originem Theorematis quod initio ponit : Item modum quo quantitates p, q, r, in suis Operationibus invenit : Ac denique quomodo in Methodo regressuum se gerat, ut cum ex Logarithmo querit Numerum. Neque enim explicat quomodo id ex methedo sua derivetur.* He pretended to have found two Series for the Number whose Logarithm was given, and yet in the same Letter desired

fired Mr. *Newton* to explain to him the Method of finding those very two Series.

When Mr. *Newton* had received this Letter, he wrote back that all the said four Series had been communicated by him to Mr. *Leibnitz*; the two first being one and the same Series in which the Letter *l* was put for the Logarithm with its Sign  $+$  or  $-$ ; and the third being the Excess of the Radius above the versed Sine, for which a Series had been sent to him. Whereupon Mr. *Leibnitz* desisted from his Claim. Mr. *Newton* also in the same Letter dated *Octob. 24. 1676.* further explained his Methods of Regression, as Mr. *Leibnitz* had desired. And Mr. *Leibnitz* in his Letter of *June 21. 1677.* desired a further Explication: but soon after, upon reading Mr. *Newton's* Letter a second time, wrote back *July 12. 1677.* that he now understood what he wanted; and found by his old Papers that he had formerly used one of Mr. *Newton's* Methods of Regression, but in the Example which he had then by chance made use of, there being produced nothing elegant, he had, out of his usual Impatience, neglected to use it any further. He had therefore several direct Series, and by consequence a Method of finding them, before he invented and forgot the inverse Method. And if he had searched his old Papers diligently, he might have found this Method also there; but having forgot his own Methods he wrote for Mr. *Newton's*.

When Mr. *Newton* in his Letter dated *June 13. 1676.* had explained his Method of Series, he added: *Ex his videre est quantum fines Analyseos per hujusmodi infinitas aequationes ampli-  
antur: quippe quæ earum beneficio ad omnia pene dixerim proble-  
mata (si numeralia Diophanti & similia excipias) sese extendit.  
Non tamen omnino universalis evadit, nisi per ulteriores quasdam  
Methodos eliciendi Series infinitas. Sunt enim quedam Problema-  
ta in quibus non licet ad Series infinitas per Divisionem vel Extra-  
ctionem radicum simplicium affectarumve pervenire. Sed quomodo  
in istis casibus procedendum sit jam non vacat dicere; ut neque  
alia quedam tradere, quæ circa Reductionem infinitarum Serierum*

*in finitas, ubi rei natura tulerit, excogitavi. Nam parcius scribo, quod hæ speculationes diu mihi fastidio esse cœperunt; adeo ut ab iisdem jam per quinque fere annos abstinuerim.* To this Mr. Leibnitz in his Letter of August 27. 676. answered: *Quod dicere videmini plerasque difficultates (exceptis Problematis Diophantæis) ad series Infinitas reduci; id mihi non videtur. Sunt enim multa usque adeo mira & implexa ut neque ab æquationibus pendeant neque ex Quadraturis. Qualia sunt (ex multis aliis) Problemata methodi Tangentium inversæ.* And Mr. Newton in his Letter of Octob. 24. 1676, replied: *Ubi dixi omnia pene Problemata solubilia existere; volui de iis præsertim intelligi circa quæ Mathematici se hæcenus occuparunt vel saltem in quibus Ratiocinia Mathematica locum aliquem obtinere possunt. Nam alia sane adeo perplexis conditionibus implicata excogitare liceat, ut non satis comprehendere valeamus: & multo minus tantarum computationum onus sustinere quod ista requirerent. Attamen ne nimium dixisse videar, inversa de Tangentibus Problemata sunt in potestate, aliaque illis difficultiora. Ad quæ solvenda usus sum duplici methodo, una concinniori, altera generatiori. Utramque visum est impræsentis literis transpositis consignare, ne propter alios idem obtinentes, institutum in aliquibus mutare cogerer.* 5 a c c d æ 10 e f f h, &c. id est, *Una methodus consistit in extractione fluentis quantitatis ex æquatione simul involvente fluxionem ejus altera tantum in assumptione seriei pro quantitate qualibet incognita, ex qua cætera commodè derivari possunt; & in collatione terminorum homologorum æquationis resultantis ad eruendos terminos assumptæ seriei.* By Mr. Newton's two Letters, its certain that he had then (or rather above five Years before) found out the Reduction of Problems to fluxional Equations and converging Series: and by the Answer of Mr. Leibnitz to the first of those Letters, its as certain that he had not then found out the Reduction of Problems either to differential Equations or to converging Series.

And the same is manifest also by what Mr. Leibnitz wrote in the *Acta Eruditorum*, Anno 1691, concerning this Matter.

Jam



Jam anno 1675, scith he, *compositum habebam opusculum Quadraturæ Arithmetica ab amicis ab illo tempore lectum, sed quod, materia sub manibus crescente, limare ad Editionem non vacavit, postquam alia occupationes supervenere; præsertim cum nunc prolixius exponere vulgari more quæ Analyfis nostra paucis exhibet, non satis opera pretium videatur.* This Quadrature composed *vulgari more* he began to communicate at *Paris* in the Year 1675. The next Year he was polishing the Demonstration thereof, to send it to Mr. Oldenburgh in Recompence for Mr. Newton's Method, as he wrote to him *May 12. 1676*; and accordingly in his Letter of *August 27. 1676.* he sent it composed and polished *vulgari more.* The Winter following he returned into *Germany*, by *England* and *Holland*, to enter upon publick Business, and had no longer any Leisure to fit it for the Press, nor thought it afterwards worth his while to explain those Things prolixly in the vulgar manner which his new *Analyfis* exhibited in short. He found out this new *Analyfis* therefore after his Return into *Germany*, and by consequence not before the Year 1677:

The same is further manifest by the following Consideration. Dr. Barrow published his *Method of Tangents* in the Year 1670. Mr. Newton in his Letter dated *December 10. 1672.* communicated his *Method of Tangents* to Mr. Collins, and added: *Hoc est unum particulare vel Corollarium potius Methodi generalis, quæ extendit se citra molestum ullum calculum, non modo ad ducendum Tangentes ad quasvis Curvas sive Geometricas sive Mechanicas, vel quomodocunque rectas Lineas aliasve Curvas respicientes; verum etiam ad resolvendum alia abstrusiora Problematum genera de Curvitatibus, Arcis, Longitudinibus, Centris Gravitatis Curvarum, &c. Neque (quemadmodum Huddeni methodus de Maximis & Minimis) ad solas restringitur equationes illas, quæ quantitibus surdis sunt immunes. Hanc methodum intertexui alteri isti quæ Equationum Exegefin instituo, reducendo eas ad series infinitas.* Mr. Slusius sent his *Method of Tangents* to Mr. Oldenburgh *Jan. 17. 1672*, and the same was

soon after published in the *Transactions*. It proved to be the same with that of Mr *Newton*. It was founded upon three *Lemmas*, the first of which was this, *Differentia duarum dignitatum ejusdem gradus applicata ad differentiam laterum dat partes singulares gradus inferioris ex binomio laterum*, ut  $\frac{y^3 - x^3}{y - x} = yy$

+  $yx$  +  $xx$ , that is, in the Notation of Mr. *Leibnitz*  $\frac{dy^3}{dy} =$

$= 3yy$ . A Copy of Mr *Newton*'s Letter of Decemb. 10. 1672 was sent to Mr. *Leibnitz* by Mr *Oldenburg* amongst the Papers of Mr *James Gregory*, at the same time with Mr. *Newton*'s Letter of June 13. 1676. And Mr. *Newton* having described in these two Letters that he had a very general *Analysis*, consisting partly of the Method of converging Series, partly of another Method, by which he applied those Series to the Solution of almost all Problems (except perhaps some numeral ones like those of *Diophantus*) and found the Tangents, Areas, Lengths, solid Contents, Centers of Gravity, and Curvities of Curves, and curvilinear Figures Geometrical or Mechanical, without sticking at Surds; and that the Method of Tangents of *Slusius* was but a Branch or Corollary of this other Method: Mr. *Leibnitz* in his returning Home through *Holland*, was meditating upon the Improvement of the Method of *Slusius*. For in a Letter to Mr. *Oldenburgh*, dated from *Amsterdam* Nov. 18. 1676, he wrote thus. *Methodus Tangentium à Slusio publicata nondum rei fastigium tenet. Potest aliquid amplius præstari in eo genere quod maximi foret usus ad omnis generis Problemata: etiam ad meam (sine extractionibus) Equationum ad series reductionem. Nimirum posset brevis quædam calculari circa Tangentes Tabula, eousque continuanda donec progressio Tabula apparet; ut eam scilicet quisque quousque libuerit sine calculo continuare possit.* This was the Improvement of the Method of *Slusius* into a general Method, which Mr. *Leibnitz* was then thinking upon, and by his Words,  
Potest

*Potest aliquid amplius præstari in eo genere quod maximi foret usus ad omnis generis Problemata,* it seems to be the only Improvement which he had then in his Mind for extending the Method to all sorts of Problems. The Improvement by the differential Calculus was not yet in his Mind, but must be referred to the next Year.

Mr. *Newton* in his next Letter, dated *Octob. 24. 1676,* mentioned the *Analysis* communicated by Dr. *Barrow* to Mr. *Collins* in the Year 1669, and also another Tract written in 1671. about converging Series, and about the other Method by which Tangents were drawn after the Method of *Slusius*, and *Maxima* and *Minima* were determined, and the Quadrature of Curves was made more easy, and this without sticking at Radicals, and by which Series were invented which brake off and gave the Quadrature of Curves in finite Equations when it might be. And the Foundation of these Operations he comprehended in this Sentence exprest enigmatically as above. *Data equatione fluentes quocunque quantitates involvente fluxiones invenire, & vice versa.* Which puts it past all Dispute that he had invented the Method of Fluxions before that time. And if other things in that Letter be considered, it will appear that he had then brought it to great Perfection, and made it exceeding general; the Propositions in his Book of Quadratures, and the Methods of converging Series and of drawing a Curve Line through any Number of given Points, being then known to him. For when the Method of Fluxions proceeds not in finite Equations, he reduces the Equations into converging Series by the binomial Theoreme, and by the Extraction of Fluents out of Equations involving or not involving their Fluxions. And when finite Equations are wanting, he deduces converging Series from the Conditions of the Probleme, by assuming the Terms of the Series gradually, and determining them by these Conditions. And when Fluents are to be derived from Fluxions, and the Law of the Fluxions is wanting, he finds

that Law *quam proxime*, by drawing a Parabolick Line through any Number of given Points. And by these Improvements Mr. *Newton* had in those Days made his Method of Fluxions much more universal than the Differential Method of Mr. *Leibnitz* is at present.

This Letter of Mr. *Newton*'s, dated *Octob. 24. 1676*, came to the Hands of Mr. *Leibnitz* in the End of the Winter or Beginning of the Spring following; and Mr. *Leibnitz* soon after, *viz. in a Letter dated June 21. 1677*, wrote back : *Clarissimi Slusii methodum Tangentium nondum esse absolutam Celeberrimo Newtono assentior. Et jam à multo tempore rem Tangentium generalius tractavi, scilicet per differentias Ordinatarum. ——— Hinc nominando, in posterum, dy differentiam duarum proximarum y &c.* Here Mr. *Leibnitz* began first to propose his Differential Method, and there is not the least Evidence that he knew it before the Receipt of Mr. *Newton*'s last Letter. He saith indeed, *Jam à multo tempore rem Tangentium generalius tractavi, scilicet per differentias Ordinatarum* : and so he affirmed in other Letters, that he had invented several converging Series direct and inverse before he had the Method of inventing them ; and had forgot an inverse Method of Series before he knew what use to make of it. But no Man is a Witness in his own Cause. A Judge would be very unjust, and act contrary to the Laws of all Nations, who should admit any Man to be a Witness in his own Cause. And therefore it lies upon Mr. *Leibnitz* to prove that he found out this Method long before the Receipt of Mr. *Newton*'s Letters. And if he cannot prove this, the Question, Who was the first Inventor of the Method, is decided.

The Marquis *De l' Hospital* (a Person of very great Candour) in the Preface to his Book *De Analyfi quantitatum infinite parvarum*, published *A. C. 1696*. tells us, that a little after the Publication of the Method of Tangents of *Des Cartes*, Mr. *Fermat* found also a Method, which *Des Cartes* himself at length allowed to be, for the most part, more simple than  
his

' his own. But it was not yet so simple as Mr. *Barrow* afterwards made it, by considering more nearly the nature of Polygons, which offers naturally to the Mind a little Triangle, compos'd of a Particle of the Curve lying between two Ordinates infinitely near one another, and of the Difference of these two Ordinates, and of that of the two correspondent *Abscissa's*. And this Triangle is like that which ought to be made by the Tangent, the Ordinate, and the Sub-tangent: so that by one simple Analogy, this last Method saves all the Calculation which was requisite either in the Method of *Des Cartes*, or in this same Method before. Mr. *Barrow* stopt not here, he invented also a sort of Calculation proper for this Method. But it was necessary in this as well as in that of *Des Cartes*, to take away Fractions and Radicals for making it useful. Upon the Defect of this Calculus, that of the celebrated Mr. *Leibnitz* was introduced, and this learned Geometer began where Mr. *Barrow* and others left off. This his *Calculus* led into Regions hitherto unknown, and there made Discoveries which astonished the most able Mathematicians of *Europe*, &c. Thus far the Marquis. He had not seen Mr. *Newton's Analysis*, nor his Letters of Decem. 10. 1672. June 13. 1676, and Octob. 24. 1676 : and so not knowing that Mr. *Newton* had done all this and signified it to Mr. *Leibnitz*, he reckoned that Mr. *Leibnitz* began where Mr. *Barrow* left off, and by teaching how to apply Mr. *Barrow's* Method without sticking at Fractions and Surds, had enlarged the Method wonderfully. And Mr. *James Bernoulli*, in the *Acta Eruditorum* of January 1691 pag. 14. writes thus: *Qui calculum Barrovianum (quem in Lectionibus suis Geometricis adumbravit Auctor, cujusque Specimina sunt tota illa Propositionum inibi contentarum farrago,) intellexerit, [calculus] alterum à Domino Leibnitio inventum, ignorare vix poterit; utpote qui in priori illo fundatus est, & nisi forte in Differentialium notatione & operationis aliquo compendio ab eo non differt.*

Now

Now Dr. *Barrow*, in his Method of Tangents, draws two Ordinates indefinitely near to one another, and puts the Letter *a* for the Difference of the Ordinates, and the Letter *e* for the Difference of the *Abscissa's*, and for drawing the Tangent gives these Three Rules 1. *Inter computandum*, saith he, *omnes abjicio terminos in quibus ipsarum a vel e potestas habeatur, vel in quibus ipse ducuntur in se. Etenim isti termini nihil valebunt.* 2. *Post equationem constitutam omnes abjicio terminos literis constantes quantitates notas seu determinatas significantibus, aut in quibus non habentur a vel e. Etenim illi termini semper ad unam equationis partem adducti nihilum adaequabunt.* 3. *Pro a Ordinatum, & pro e Subtangenter substituo. Hinc demum Subtangenteris quantitas dignoscetur.* Thus far Dr. *Barrow*.

And Mr. *Leibnitz* in his Letter of June 21. 1677 above-mentioned, wherein he first began to propose his Differential Method, has followed this Method of Tangents exactly, excepting that he has changed the Letters *a* and *e* of Dr. *Barrow* into *dx* and *dy*. For in the Example which he there gives, he draws two parallel Lines and sets all the Terms below the under Line, in which *dx* and *dy* are (severally or jointly) of more than one Dimension, and all the Terms above the upper Line, in which *dx* and *dy* are wanting, and for the Reasons given by Dr. *Barrow*, makes all these Terms vanish. And by the Terms in which *dx* and *dy* are but of one Dimension, and which he sets between the two Lines, he determines the Proportion of the Subtangent to the Ordinate. Well therefore did the Marquis *de l'Hospital* observe that where Dr. *Barrow* left off Mr. *Leibnitz* began: for their Methods of Tangents are exactly the same.

But Mr. *Leibnitz* adds this Improvement of the Method, that the Conclusion of this Calculus is coincident with the Rule of *Slusius*, and shews how that Rule presently occurs to any one who understands this Method. For Mr. *Newton* had represented in his Letters, that this Rule was a Corollary of his general Method.

And

And whereas Mr. *Newton* had said that his Method in drawing of Tangents, and determining *Maxima* and *Minima*, &c. proceeded without sticking at Surds : Mr. *Leibnitz* in the next Place, shews how this Method of Tangents may be improved so as not to stick at Surds or Fractions, and then adds: *Arbitror quæ celare voluit Newtonus de Tangentibus ducendis ab his non abludere. Quod addit, ex hoc eodem fundamento Quadraturas quoque reddit faciliores me in hac sententia confirmat ; nimirum semper figura illa sunt quadrabiles quæ sunt ad æquationem differentialem.* By which Words, compared with the preceding Calculation, its manifest that Mr. *Leibnitz* at this time understood that Mr. *Newton* had a Method which would do all these things, and had been examining whether Dr. *Barrow's* Differential Method of Tangents might not be extended to the same Performances.

In November 1684 Mr. *Leibnitz* published the Elements of this Differential Method in the *Acta Eruditorum*, and illustrated it with Examples of drawing Tangents and determining *Maxima* and *Minima*, and then added. *Et hæc quidem initia sunt Geometriæ cujusdam multo sublimioris, ad difficillima & pulcherrima quaque etiam mistæ Matheseos Problemata pertingentis, quæ sine calculo differentiali AUT SIMILI non temere quisquam pari facilitate tractabit.* The Words AUT SIMILI plainly relate to Mr. *Newton's* Method. And the whole Sentence contains nothing more than what Mr. *Newton* had affirmed of his general Method in his Letters of 1672 and 1676.

And in the *Acta Eruditorum* of June 1686, pag. 297. Mr. *Leibnitz* added: *Malo autem dx & similia adhibere quam literas pro illis, quia istud dx est modificatio quedam ipsius x, &c.* He knew that in this Method he might have used Letters with Dr. *Barrow*, but chose rather to use the new Symbols *dx* and *dy*, though there is nothing which can be done by these Symbols, but may be done by single Letters with more brevity.

The next Year Mr. Newton's *Principia Philosophiæ* came abroad, a Book full of such Problemes as Mr. Leibnitz had called *difficillima & pulcherrima etiam mistæ Matheseos problema-ta, quæ sine calculo differentiali aut SIMILI non temere quisquam pari facilitate tractabit*. And the Marquess de L'Hospital has represented this Book *presque tout de ce calcul*; composed almost wholly of this Calculus. And Mr. Leibnitz himself in a Letter to Mr. Newton, dated from *Hannover, March 7, 1693* and still extant in his own Hand-writing, and upon a late Occasion communicated to the Royal Society, acknowledged the same thing in these Words: *Mirifice amplius Geometriam tuis Seriebus, sed edito Principiorum opere ostendisti patere tibi etiam quæ Analyti receptæ non subsunt. Conatus sum ego quoque, notis commodis adhibitis quæ differentias & summas exhibeant, Geometriam illam quam Transcendentem appello Analyti quodammodo subicere, nec res male processit*; And again in his Answer to Mr. Fatio, printed in the *Acta Eruditorum* of May 1700. pag. 203. lin. 21. he acknowledged the same thing. In the second Lemma of the second Book of these *Principles*, the Elements of this Calculus are demonstrated synthetically, and at the End of the Lemma there is a Scholium in these Words. *In Literis quæ mihi cum Geometra peritissimo G. G. Leibnitio annis abhinc decem intercedebant, cum significarem me compotem esse methodi determinandi Maximas & Minimas, ducendi Tangentes & similia peragendi, quæ in terminis surdis æque ac in rationalibus procederet; & literis transpositis hanc sententiam involventibus [Data æquatione quocunque fluentes quantitates involvente, fluxiones invenire, & vice versa] eandem celarem: rescriptit Vir clarissimus se quoque in ejusmodi methodum incidisse, & methodum suam communicavit à mea vix abludentem præterquam in verborum & notarum formulis. Utriusque fundamentum continetur in hoc Lemmate*. In those Letters, and in another dated *Decem. 10. 1672*, a Copy of which, at that time, was sent to Mr. Leibnitz by Mr. Oldenburgh, as is mentioned above, Mr. Newton had so far explained his Method, that it was not difficult for Mr.



Mr. *Leibnitz*, by the Help of Dr. *Barrow*'s Method of Tangents, to collect it from those Letters. And its certain, by the Arguments above-mentioned, that he did not know it before the writing of those Letters.

Dr. *Wallis* had received Copies of Mr. *Newton*'s two Letters of *June 13.* and *Octob. 24.* 1676 from Mr. *Oldenburgh*, and published several things out of them in his *Algebra*, printed in *English* 1683, and in *Latin* 1693; and soon after had Intimation from *Holland* to print the Letters entire, because Mr. *Newton*'s Notions of Fluxions passed there with Applause by the Name of the Differential Method of Mr. *Leibnitz*. And thereupon he took notice of this Matter in the Preface to the first Volume of his Works published *A. C.* 1695. And in a Letter to Mr. *Leibnitz* dated *Decemb. 1.* 1696, he gave the Account of it. *Cum Praefationis (praefigendae) postremum folium erat sub prelo, ejusque typos jam posuerant Typothetae; me monuit amicus quidam (harum rerum gnarus) qui peregre fuerat, tum talem methodum in Belgio praedicari, tum illam cum Newtoni methodo Fluxionum quasi coincidere. Quod fecit ut (translatis typis jam positis) id monitum interseruerim.* And in a Letter dated *April 10.* 1695, and lately communicated to the Royal-Society, he wrote thus about it. *I wish you would print the two large Letters of June and August [he means June and October] 1676. I had intimation from Holland, as desired there by your Friends, that somewhat of that kind were done; because your Notions (of Fluxions) pass there with great Applause by the Name of Leibnitz's Calculus Differentialis. I had\* this intimation when all but part of the Preface to this Volume was printed off; so that I could only insert (while the Press stay'd) that short Intimation thereof which you there find. You are not so kind to your Reputation (and that of the Nation) as you might be, when you let things of worth lye by you so long, till others carry away*

---

\* Extat hæc Epistola in tertio volumine operum *Wallisi*.

*the Reputation that is due to you. I have endeavoured to do you Justice in that Point, and am now sorry that I did not print those two Letters verbatim.*

The short Intimation of this Matter, which Dr. Wallis inserted into the said Preface, was in these Words. *In secundo Volumine (inter alia) habetur Newtoni Methodus de Fluxionibus (ut ille loquitur) consimilis naturæ cum Leibnitii (ut hic loquitur) Calculo Differentiali (quod qui utramque methodum contulerit satis animadvertat, ut ut sub loquendi formulis diversis) quam ego descripsi (Algebra cap. 91. &c. præsertim cap. 95) ex binis Newtoni Literis, aut earum alteris, Junii 13. & Octob. 24. 1676 ad Oldenburgum datis, cum Leibnitio tum communicandis (iisdem fere verbis, saltem leviter mutatis, quæ in illis literis habentur.) ubi METHODUM HANC LEIBNITIO EX-  
PONIT, tum ante DECEM ANNOS nedum plures [id est, anno 1666 vel 1665] ab ipso excogitatam. Quod moneo, nequis causetur de hoc Calculo Differentiali nihil à nobis dictum esse.*

Hereupon the Editors of the *Acta Lipsensia*, the next Year in June, in the Style of Mr. Leibnitz, in giving an Account of these two first Volumes of Dr. Wallis, took notice of this Clause of the Doctor's Preface, and complained, not of his saying that Mr. Newton in his two Letters above-mentioned explained to Mr Leibnitz the Method of Fluxions found by him Ten Years before or above; but that while the Doctor mentioned the Differential Calculus, and said that he did it *nequis causetur de calculo differentiali nihil ab ipso dictum fuisse*, he did not tell the Reader that Mr. Leibnitz had this Calculus at that time when those Letters passed between him and Mr. Newton, by means of Mr. Oldenburgh. And, in several Letters which followed hereupon, between Mr. Leibnitz and Dr. Wallis, concerning this Matter, Mr. Leibnitz denied not that Mr. Newton had the Method Ten Years before the writing of those Letters, as Dr. Wallis had affirmed; pretended not that he himself had the Method so early; brought no Proof that he had it before the Year

1677; no other Proof besides the Concession of Mr. *Newton* that he had it so early; affirmed not that he had it earlier; commended Mr. *Newton* for his Candour in this Matter; allowed that the Methods agreed in the main, and said that he therefore used to call them by the common Name of his *Infinitesimal Analysis*; represented, that as the Methods of *Vieta* and *Cartes* were called by the common Name of *Analysis Speciosa*, and yet differed in some things; so perhaps the Methods of Mr. *Newton* and himself might differ in some things, and challenged to himself only those things wherein, as he conceived, they might differ, naming the Notation, the differential Equations and the Exponential Equations. But in his Letter of June 21. 1677 he reckon'd differential Equations common to Mr. *Newton* and himself.

This was the State of the Dispute between Dr. *Wallis* and Mr. *Leibnitz* at that time And Four years after, when Mr. *Fatio* suggested that Mr. *Leibnitz*, the second Inventor of this Calculus, might borrow something from Mr. *Newton*, the oldest Inventor by many Years: Mr. *Leibnitz* in his Answer, published in the *Acta Eruditorum* of May 1700, allowed that Mr. *Newton* had found the Method apart, and did not deny that Mr. *Newton* was the oldest Inventor by many Years, nor asserted any thing more to himself, than that he also had found the Method apart, or without the Assistance of Mr. *Newton*, and pretended that when he first published it, he knew not that Mr. *Newton* had found any thing more of it than the Method of Tangents. And in making this Defence he added: *Quam* [methodum] *ante Dominum Newtonum & Me nullus quod sciam Geometra habuit; uti ante hunc maximi nominis Geometram N E M O specimine publice dato se habere probavit, ante Dominos Bernoullios & Me nullus communicavit.* Hitherto therefore Mr. *Leibnitz* did not pretend to be the first Inventor. He did not begin to put in such a Claim till after the Death of Dr. *Wallis*, the last of the old Men who were acquainted with what had passed between the *English* and Mr. *Leibnitz*.

Forty Years ago. The Doctor died in *October A.C. 1703*, and Mr. *Leibnitz* began not to put in this new Claim before *January 1705*.

Mr. *Newton* published his *Treatise of Quadratures* in the Year 1704. This Treatise was written long before, many things being cited out of it in his Letters of *Octob. 24.* and *Novemb. 8. 1676.* It relates to the Method of Fluxions, and that it might not be taken for a new Piece, Mr. *Newton* repeated what Dr. *Wallis* had published Nine Years before without being then contradicted, namely, that this Method was invented by Degrees in the Years 1665 and 1666. Hereupon the Editors of the *Acta Lipsiensia* in *January 1705.* in the Style of Mr. *Leibnitz*, in giving an Account of this Book, represented that Mr. *Leibnitz* was the first Inventor of the Method, and that Mr. *Newton* had substituted Fluxions for Differences. And this Accusation gave a Beginning to this present Controversy.

For Mr. *Keill*, in an Epistle published in the *Philosophical Transactions* for *Sept. and Octob. 1708*, retorted the Accusation, saying : *Fluxionum Arithmeticam sine omni dubio primus invenit D. Newtonus, ut cuilibet ejus Epistolas à Wallisio editas legenti facile constabit. Eadem tamen Arithmetica postea mutatis nomine & notationis modo à Domino Leibnitio in Actis Eruditorum edita est.*

Before Mr. *Newton* saw what had been published in the *Acta Lipsica*, he express'd himself offended at the printing of this Paragraph of Mr. *Keill*'s Letter, least it should create a Controversy. And Mr. *Leibnitz*, understanding it in a stronger Sense than Mr. *Keill* intended it, complain'd of it as a Calumny, in a Letter to Dr. *Sloane* dated *March 4. 1711 N.S.* and moved that the Royal-Society would cause Mr. *Keill* to make a publick Recantation. Mr. *Keill* chose rather to explain and defend what he had written ; and Mr. *Newton*, upon being shewed the Accusation in the *Acta Lipsica*, gave him leave to do so. And Mr. *Leibnitz* in a second Letter to Dr. *Sloane*, dated *Decem. 29. 1711*, instead of making good his Accu-  
sation

sation, as he was bound to do that it might not be deem'd a Calumny, insisted only upon his own Candour, as if it would be Injustice to question it ; and refus'd to tell how he came by the Method ; and said that the *Acta Lipsica* had given every Man his due, and that he had concealed the Invention above Nine Years, (he should have said Seven Years) that No body might pretend (he means that Mr. *Newton* might not pretend) to have been before him in it ; and called Mr. *Keill* a Novice unacquainted with things past, and one that acted without Authority from Mr. *Newton*, and a clamorous Man who deserved to be silenced, and desired that Mr. *Newton* himself would give his Opinion in the Matter. He knew that Mr. *Keill* affirmed nothing more than what Dr. *Wallis* had published thirteen Years before, without being then contradicted. He knew that Mr. *Newton* had given his Opinion in this matter in the Introduction to his Book of *Quadratures*, published before this Controversy began : but Dr. *Wallis* was dead ; the Mathematicians which remained in *England* were Novices ; Mr. *Leibnitz* may Question any Man's Candour without Injustice, and Mr. *Newton* must now retract what he had published or not be quiet.

The Royal-Society therefore, having as much Authority over Mr. *Leibnitz* as over Mr. *Keill*, and being now twice pressed by Mr. *Leibnitz* to interpose, and seeing no reason to condemn or censure Mr. *Keill* without enquiring into the matter ; and that neither Mr. *Newton* nor Mr. *Leibnitz* (the only Persons alive who knew and remembred any thing of what had passed in these matters Forty Years ago) could be Witnesses for or against Mr. *Keill* ; appointed a numerous Committee to search old Letters and Papers, and report their Opinion upon what they found ; and ordered the Letters and Papers, with the Report of their Committee to be published. And by these Letters and Papers it appear'd to them, that Mr. *Newton* had the Method in or before the Year 1669, and it did not appear to them that Mr. *Leibnitz* had it before the Year 1677.

For

For making himself the first Inventor of the Differential Method, he has represented that Mr. *Newton* at first used the Letter *o* in the vulgar manner for the given Increment of  $x$ , which destroys the Advantages of the Differential Method; but after the writing of his Principles, changed *o* into  $\dot{x}$ , substituting  $\dot{x}$  for  $dx$ . It lies upon him to prove that Mr. *Newton* ever changed *o* into  $\dot{x}$ , or used  $\dot{x}$  for  $dx$ , or left off the Use of the Letter *o*. Mr. *Newton* used the Letter *o* in his *Analysis* written in or before the Years 1669, and in his Book of *Quadratures*, and in his *Principia Philosophiæ*, and still uses it in the very same Sense as at first. In his Book of *Quadratures* he used it in conjunction with the Symbol  $\dot{x}$ , and therefore did not use that Symbol in its Room. These Symbols *o* and  $\dot{x}$  are put for things of a different kind. The one is a Moment, the other a Fluxion or Velocity as has been explained above. When the Letter  $x$  is put for a Quantity which flows uniformly, the Symbol  $\dot{x}$  is an Unit, and the Letter *o* a Moment, and  $\dot{x}o$  and  $dx$  signify the same Moment. Prickt Letters never signify Moments, unless when they are multiplied by the Moment *o* either exprest or understood to make them infinitely little, and then the Rectangles are put for Moments.

Mr. *Newton* doth not place his Method in Forms of Symbols, nor confine himself to any particular Sort of Symbols for Fluents and Fluxions. Where he puts the Areas of Curves for Fluents, he frequently puts the Ordinates for Fluxions, and denotes the Fluxions by the Symbols of the Ordinates, as in his *Analysis*. Where he puts Lines for Fluents, he puts any Symbols for the Velocities of the Points which describe the Lines, that is, for the first Fluxions; and any other Symbols for the Increase of those Velocities, that is, for the second Fluxions, as is frequently done in his *Principia Philosophiæ*. And where he puts the Letters  $x, y, z$  for Fluents, he denotes their Fluxions, either by other Letters as  $p, q, r$ ; or by the same Letters in other Forms as  $X, T, Z$  or  $\dot{x}, \dot{y}, \dot{z}$ ; or by any

any Lines as *DE*, *FG*, *HI*, considered as their Exponents. And this is evident by his Book of *Quadratures*, where he represents Fluxions by prickd Letters in the first Proposition, by Ordinates of Curves in the last Proposition, and by other Symbols, in explaining the Method and illustrating it with Examples, in the Introduction. Mr. *Leibnitz* hath no Symbols of Fluxions in his Method, and therefore Mr. *Newton's* Symbols of Fluxions are the oldest in the kind. Mr. *Leibnitz* began to use the Symbols of Moments or Differences *dx*, *dy*, *dz* in the Year 1677. Mr. *Newton* represented Moments by the Rectangles under the Fluxions and the Moment *o*, when he wrote his *Analysis*, which was at least Forty Six Years ago. Mr. *Leibnitz* has used the Symbols *fx*, *fy*, *fz* for the Sums of Ordinates ever since the Year 1686; Mr. *Newton* represented the same thing in his *Analysis*, by inscribing the Ordinate in a Square or Rectangle. All Mr. *Newton's* Symbols are the oldest in their several Kinds by many Years.

And whereas it has been represented that the use of the Letter *o* is vulgar, and destroys the Advantages of the Differential Method: on the contrary, the Method of Fluxions, as used by Mr. *Newton*, has all the Advantages of the Differential, and some others. It is more elegant, because in his Calculus there is but one infinitely little Quantity represented by a Symbol, the Symbol *o*. We have no Ideas of infinitely little Quantities, and therefore Mr. *Newton* introduced Fluxions into his Method, that it might proceed by finite Quantities as much as possible. It is more Natural and Geometrical, because founded upon the *prima quantitatum nascentium rationes*, which have a Being in Geometry, whilst *Indivisibles*, upon which the Differential Method is founded, have no Being either in Geometry or in Nature. There are *rationes prima quantitatum nascentium*, but not *quantitates prima nascentes*. Nature generates Quantities by continual Flux or Increase; and the ancient Geometers admitted such a Generation of Areas and Solids, when they drew one Line into another by local Motion

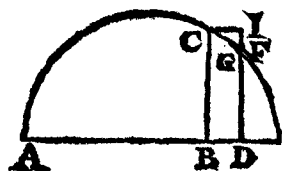
to generate an Area, and the Area into a Line by local Motion to generate a Solid. But the summing up of Individibles to compose an Area or Solid was never yet admitted into Geometry. Mr. *Newton*'s Method is also of greater Use and Certainty, being adapted either to the ready finding out of a Proposition by such Approximations as will create no Error in the Conclusion, or to the demonstrating it exactly: Mr. *Leibnitz*'s is only for finding it out. When the Work succeeds not in finite Equations Mr. *Newton* has recourse to converging Series, and thereby his Method becomes incomparably more universal than that of Mr. *Leibnitz*, which is confin'd to finite Equations: for he has no Share in the Method of infinite Series. Some Years after the Method of Series was invented, Mr. *Leibnitz* invented a Proposition for transforming curvilinear Figures into other curvilinear Figures of equal Areas, in order to square them by converging Series: but the Methods of squaring those other Figures by such Series were not his. By the help of the new *Analysis* Mr. *Newton* found out most of the Propositions in his *Principia Philosophiæ*: but because the Ancients for making things certain admitted nothing into Geometry before it was demonstrated synthetically, he demonstrated the Propositions synthetically, that the Systeme of the Heavens might be founded upon good Geometry. And this makes it now difficult for unskilful Men to see the Analysis by which those Propositions were found out.

It has been represented that Mr. *Newton*, in the Scholium at the End of his Book of Quadratures, has put the third, fourth, and fifth Terms of a converging Series respectively equal to the second, third, and fourth Differences of the first Term, and therefore did not then understand the Method of second, third, and fourth Differences. But in the first Proposition of that Book he shewed how to find the first, second, third and following Fluxions *in infinitum*; and therefore when he wrote that Book, which was before the Year 1676, he did understand the Method of all the Fluxions, and by consequence



sequence of all the Differences. And if he did not understand it when he added that Scholium to the End of the Book, which was in the Year 1704, it must have been because he had then forgot it. And so the Question is only whether he had forgot the Method of second and third Differences before the Year 1704.

In the Tenth Proposition of the second Book of his *Principia Philosophia*, in describing some of the Uses of the Terms of a converging Series for solving of Problemes, he tells us



that if the first Term of the Series represents the Ordinate  $BC$  of any Curve Line  $ACG$ , and  $CBDI$  be a Parallelogram infinitely narrow, whose Side  $DI$  cuts the Curve in  $G$  and its Tangent  $CF$  in  $F$ , the second Term of the Series will represent the Line  $IF$ , and the third Term the Line  $FG$ . Now the

Line  $FG$  is but half the second Difference of the Ordinate : and therefore Mr. *Newton* when he wrote his *Principia*, put the third Term of the Series equal to half of the second Difference of the first Term, and by consequence had not then forgotten the Method of second Differences.

In writing that Book, he had frequent occasion to consider the Increase or Decrease of the Velocities with which Quantities are generated, and argues right about it. That Increase or Decrease is the second Fluxion of the Quantity, and therefore he had not then forgotten the Method of second Fluxions.

In the Year 1692, Mr. *Newton*, at the Request of Dr. *Wallis*, sent to him a Copy of the first Proposition of the Book of Quadratures, with Examples thereof in first, second and third Fluxions : as you may see in the second Volume of the Doctor's Works, *pag.* 391, 392, 393 and 396. And therefore he had not then forgotten the Method of second Fluxions.

Nor is it likely, that in the Year 1704; when he added the aforesaid Scholium to the End of the Book of Quadratures, he had forgotten not only the first Proposition of that Book, but also the last Proposition upon which that Scholium was written. If the Word [*ut*], which in that Scholium may have been accidentally omitted between the Words [*erit*] and [*ejus*,] be restor'd, that Scholium will agree with the two Propositions and with the rest of his Writings, and the Objection will vanish.

Thus much concerning the Nature and History of these Methods, it will not be amiss to make some Observations thereupon.

In the *Commercium Epistolicum*, mention is made of three Tracts written by Mr. *Leibnitz*, after a Copy of Mr. *Newton's Principia Philosophiæ* had been sent to *Hannover* for him; and after he had seen an Account of that Book published in the *Acta Eruditorum* for *January* and *February* 1689. And in those Tracts the principal Propositions of that Book are composed in a new manner, and claimed by Mr. *Leibnitz* as if he had found them himself before the publishing of the said Book. But Mr. *Leibnitz* cannot be a Witness in his own Cause. It lies upon him either to prove that he found them before Mr. *Newton*, or to quit his claim.

In the last of those three Tracts, the 20<sup>th</sup> Proposition (which is the chief of Mr. *Newton's* Propositions) is made a Corollary of the 19<sup>th</sup> Proposition, and the 19<sup>th</sup> Proposition has an erroneous Demonstration adapted to it. It lies upon him either to satisfy the World that the Demonstration is not erroneous, or to acknowledge that he did not find that and the 20<sup>th</sup> Proposition thereby, but tried to adapt a Demonstration to Mr. *Newton's* Proposition to make it his own. For he represents in his 20<sup>th</sup> Proposition that he knew not how Mr. *Newton* came by it, and by consequence that he found it himself without the Assistance of Mr. *Newton*.

By the Errors in the 15<sup>th</sup> and 19<sup>th</sup> Proposition of the third Tract, Dr. *Kell* hath shewed that when Mr. *Leibnitz* wrote these

these three Tracts, he did not well understand the Ways of working in second Differences. And this is further manifest by the 10<sup>th</sup>, 11<sup>th</sup>, and 12<sup>th</sup> Propositions of this third Tract. For these he lays down as the Foundation of his infinitesimal Analysis in arguing about centrifugal Forces, and proposes the first of them with relation to the Center of Curvity of the Orb, but uses this Proposition in the two next, with Relation to the Center of Circulation. And by confounding these two Centers with one another in the fundamental Propositions upon which he grounds this *Calculus*, he erred in the Superstructure, and for want of Skill in second and third Differences, was not able to extricate himself from the Errors. And this is further confirmed by the sixth Article of the second Tract. For that Article is erroneous, and the Error arises from his not knowing how to argue well about second and third Differences. When therefore he wrote those Tracts he was but a Learner, and this he ought in candour to acknowledge.

It seems therefore that as he learnt the Differential Method by means of Mr. *Newton's* aforesaid three Letters compared with Dr. *Barrow's* Method of Tangents; so Ten Years after, when Mr. *Newton's Principia Philosophiæ* came abroad, he improved his Knowledge in these Matters, by trying to extend this Method to the Principal Propositions in that Book, and by this means composed the said three Tracts. For the Propositions contained in them (Errors and Trifles excepted) are Mr. *Newton's* (or easy Corollaries from them) being published by him in other Forms of Words before. And yet Mr. *Leibnitz* published them as invented by himself long before they were published by Mr. *Newton*. For in the End of the first Tract, he represents that he invented them all before Mr. *Newton's Principia Philosophiæ* came abroad, and some of them before he left *Paris*, that is before *October 1676*. And the second Tract he concludes with these Words: *Multa ex his deduci possent praxi accommodata, sed nobis*.

*his nunc fundamenta Geometrica jecisse suffecerit, in quibus maxima consistebat difficultas. Et fortassis attente consideranti vias quasdam novas satis antea impeditas aperuisse videbimur. Omnia autem respondent nostræ Analyfi Infinitorum, hoc est calculo Summarum & Differentiarum (cujus elementa quædam in his Actis dedimus) communibus quoad licuit verbis hic expresso.* He pretends here that the *Fundamenta Geometrica in quibus maxima consistebat difficultas* were first laid by himself in this very Tract, and that he himself had in this very Tract opened *vias quasdam novas satis antea impeditas*. And yet Mr. Newton's *Principia Philosophiæ* came abroad almost two Years before, and gave occasion to the Writing of this Tract, and was written *communibus quoad licuit verbis*, and contains all these Principles and all these new Ways. And Mr. Leibnitz, when he published that Tract, knew all this, and therefore ought then to have acknowledged that Mr. Newton was the first who laid the *Fundamenta Geometrica in quibus maxima consistebat Difficultas*, and opened the *vias novas satis antea impeditas*. In his Answer to Mr. Fatio he acknowledged all this, saying *Quam [methodum] ante Dominum Newtonum & me nullus quod sciam Geometra habuit; uti ante hunc maximi nominis Geometram, NEMO SPECIMINE PUBLICE DATO se habere PROBAVIT.* And what he then acknowledged he ought in Candour and Honour to acknowledge still upon all Occasions.

Mr. Leibnitz in his Letter of May 28. 1697, wrote thus to Dr. Wallis. *Methodum Fluxionum profundissimi Newtoni cognitam esse methodo meâ differentiali non tantum animadverti postquam opus ejus [Principiorum scilicet] & tuum prodiit; sed etiam professus sum in Actis Eruditorum, & alias quæque monui. Id enim candori meo convenire judicavi, non minus quam ipsius merito. Itaque communi nomine designare soleo Analyseos infinitesimalis; quæ latius quam Tetragonistica patet. Interim quemadmodum & Vietæ & Cartesiana methodus Analyseos speciosæ nomine venit; discrimina tamen nonnulla supersunt: ita fortasse*  
 &

& *Newtoniana* & *Mea differunt in nonnullis*. Here also Mr. *Leibnitz* allows that when Mr. *Newton's* Principles of Philosophy came abroad, he understood thereby the Affinity that there was between the Methods, and therefore called them both by the common Name of the infinitesimal Method, and thought himself bound in candour to acknowledge this Affinity: and there is still the same Obligation upon him in point of Candour. And besides this Acknowledgment, he here gives the Preference to Mr. *Newton's* Method in Antiquity. For he represents that as the vulgar Analysis in *Species* was invented by *Vleta*, and augmented by *Cartes*, which made some Differences between their Methods: so Mr. *Newton's* Method and his own might differ in some things. And then he goes on to enumerate the Differences by which he had improved Mr. *Newton's* Method as we mentioned above. And this Subordination of his Method to Mr. *Newton's*, which he then acknowledged to Dr. *Wallis*, he ought still to acknowledge.

In enumerating the Differences or Improvements which he had added to Mr. *Newton's* Method; he names in the second Place Differential Equations: but the Letters which passed between them in the Year 1676, do show that Mr. *Newton* had such Equations at that time, and Mr. *Leibnitz* had them not. He names in the third Place Exponential Equations: but these Equations are owing to his Correspondence with the *Englisch*. Dr. *Wallis*, in the Interpolation of Series, considered Fract and Negative Indices of Dignities. Mr. *Newton* introduced into his Analytical Computations, the Fract, Surd, Negative and Indefinitive Indices of Dignities; and in his Letter of October 24. 1676, represented to Mr. *Leibnitz* that his Method extended to the Resolution of affected Equations involving Dignities whose Indices were Fract or Surd. Mr. *Leibnitz* in his Answer dated June 21. 1677, mutually desired Mr. *Newton* to tell him what he thought of the Resolution of Equations involving Dig-

Dignities whose Indices were undetermined, such as were these  $x^y + y^x = xy$ ,  $x^x + y^y = x + y$  And these Equations he now calls Exponential, and represents to the World that he was the first Inventor thereof, and magnifies the Invention as a great Discovery. But he has not yet made a publick Acknowledgment of the Light which Mr. *Newton* gave him into it, nor produced any one Instance of the use that he has been able to make of it where the Indices of Dignities are Fluents. And since he has not yet rejected it with his usual Impatience for want of such an Instance, we have reason to expect that he will at length explain its Usefulness to the World.

Mr. *Newton* in his Letter of *October 24. 1676* wrote that he had two Methods of resolving the Inverse Problems of Tangents, and such like difficult ones; one of which consisted in assuming a Series for any unknown Quantity from which all the rest might conveniently be deduced, and in collating the homologous Terms of the resulting Equation, for determining the Terms of the assumed Series. Mr. *Leibnitz* many Years after published this Method as his own, claiming to himself the first Invention thereof. It remains that he either renounce his Claim publickly, or prove that he invented it before Mr. *Newton* wrote his said Letter.

It lies upon him also to make a publick Acknowledgment of his Receipt of Mr. *Oldenburgh's* Letter of *April 15. 1675*, wherein several converging Series for squaring of Curves, and particularly that of Mr. *James Gregory* for finding the Arc by the given Tangent, and thereby squaring the Circle, were communicated to him. He acknowledged it privately in his Letter to Mr. *Oldenburg* dated *May 20. 1675* still extant in his own Hand-writing, and by Mr. *Oldenburg* left entred in the Letter-Book of the *Royal-Society*. But he has not yet acknowledged it publickly, as he ought to have done when he published that Series as his own.

It lies upon him also to make a publick Acknowledgment of his having received the Extracts of Mr. *James Gregory's* Letters, which, at his own Request, were sent to him at *Paris* in *June* 1676 by Mr. *Oldenburgh* to peruse: amongst which was Mr. *James Gregory's* Letter of *Feb.* 15. 1671, concerning that Series, and Mr. *Newton's* Letter of *December* 10. 1672 concerning the Method of Fluxions.

And whereas in his Letter of *Decem.* 28. 1675. he wrote to Mr. *Oldenburgh*, that he had communicated that Series above two Years before to his Friends at *Paris*, and had written to him sometimes about it; and in his Letter of *May* 12. 1676 said to Mr. *Oldenburgh* that he had written to him about that Series some Years before; and in his Letter to Mr. *Oldenburgh* dated *Aug.* 27. 1676, that he had communicated that Series to his Friends above three Years before; that is, upon his first coming from *London* to *Paris*: He is desired to tell us how it came to pass, that when he received Mr. *Oldenburgh's* Letter of *Apr.* 15. 1675 he did not know that Series to be his own.

In his Letters of *July* 15. and *Octob.* 26. 1674, he tells us of but one Series for the circumference of a Circle, and saith that the Method which gave him this Series, gave him also a Series for any Arc whose Sine was given, tho' the Proportion of the Arc to the whole Circumference be not known. This Method therefore, by the given Sine of 30 Degrees, gave him a Series for the whole Circumference. If he had also a Series for the whole Circumference deduced from the Tangent of 45 Degrees, he is desired to tell the World what Method he had in those Days, which could give him both those Series. For the Method by the Transmutation of Figures will not do it. He is desired also to tell us why in his said Letters he did not mention more Quadratures of the Circle than one.

And if in the Year 1674 he had the Demonstration of a Series for finding any Arc whose Sine is given, he is desired

to tell the World what it was ; and why in his Letter of *May* 12. 1676 he desired Mr. *Oldenburgh* to procure from Mr. *Collins* the Demonstration of Mr. *Newton's* Series for doing the same thing ; and wherein his own Series differed from Mr. *Newton's*. For upon all these Considerations there is a Suspicion that Mr. *Newton's* Series for finding the Arc whose Sine is given, was communicated to him in *England* ; and that in the Year 1673 he began to communicate it as his own to some of his Friends at *Paris*, and the next Year wrote of it as his own in his Letters to Mr. *Oldenburgh*, in order to get the Demonstration or Method of finding such Series. But the Year following, when Mr. *Oldenburgh* sent him this Series and the Series of Mr. *Gregory* and Six other Series, he dropt his Pretence to this Series for want of a Demonstration, and took time to consider the Series sent him, and to compare them with his own, as if his Series were others different from those sent him. And when he had found a Demonstration of *Gregory's* Series by a Transmutation of Figures, he began to communicate it as his own to his Friends at *Paris*, as he represents in the *Acta Eruditorum* for April 1691. pag. 178, saying; *Jam Anno 1675 compositum habebam opusculum Quadraturæ Arithmetica ab Amicis ab illo tempore lectum, &c.* But the Letter by which he had received this Series from Mr. *Oldenburgh* he concealed from his Friends, and pretended to Mr. *Oldenburgh* that he had this Series a Year or two before the Receipt of that Letter. And the next Year, upon receiving two of Mr. *Newton's* Series again by one *George Mohr*, he wrote to Mr. *Oldenburgh* in such a manner as if he had never seen them before, and upon Pretence of their Novelty, desired Mr. *Oldenburgh* to procure from Mr. *Collins* Mr. *Newton's* Method of finding them. If Mr. *Leibnitz* thinks fit to obviate this Suspicion, he is in the first Place to prove that he had Mr. *Gregory's* Series before he received it from Mr. *Oldenburgh*.



It lies upon him also to tell the World what was the Method by which the several Series of Regression for the Circle and Hyperbola, sent to him by Mr. *Newton* June 13. 1676, and claimed as his own by his Letter of *August* 27. following, were found by him before he received them from Mr. *Newton*.

And whereas Mr. *Newton* sent him, at his own Request, a Method of Regression, which upon the first reading he did not know to be his own, nor understood it; but so soon as he understood it he claimed as his own, by pretending that he had found it long before, and had forgot it, as he perceived by his old Papers: it lies upon him, in point of Candor and Justice, either to prove that he was the first Inventor of this Method, or to renounce his Claim to it for preventing future Disputes.

Mr. *Leibnitz* in his Letter to Mr. *Oldenburgh* dated *Feb.* 3. 1677, claimed a Right to a certain Property of a Series of Numbers Natural, Triangular, Pyramidal, Triangulo-Triangular, &c. and to make it his own, represented that he wondred that Monsieur *Pascal*, in his Book entituled *Triangulum Arithmeticum*, should omit it. That Book was published in the Year 1665, and contains this Property of the Series; and Mr. *Leibnitz* has not yet done him the Justice to acknowledge that he did not omit it. It lies upon him therefore in Candor and Justice, to renounce his Claim to this Property, and acknowledge Mr. *Pascal* the first Inventor.

He is also to renounce all Right to the Differential Method of *Mouton* as second Inventor: for second Inventors have no Right. The sole Right is in the first Inventor until another finds out the same thing apart. In which case to take away the Right of the first Inventor, and divide it between him and that other, would be an Act of Injustice.

In his Letter to Dr. *Sloane* dated *Decem.* 29. 1711. he has told us that his Friends know how he came by the Differential Method. It lies upon him, in point of Candor, openly and plainly, and without further Hesitation, to satisfy the World how he came by it.

In the same Letter he has told us that he had this Method above Nine Years before he published it, and it follows from thence that he had it in the Year 1675 or before. And yet its certain that he had it not when he wrote his Letter to Mr. Oldenburgh dated Aug. 27. 1676, wherein he affirmed that Problems of the Inverse Method of Tangents and many others, could not be reduced to infinite Series, nor to Equations or Quadratures. It lies upon him therefore, in point of Candor, to tell us what he means by pretending to have found the Method before he had found it.

We have shewed that Mr. Leibnitz in the End of the Year 1676, in returning home from France through England and Holland, was meditating how to improve the Method of Slusius for Tangents, and extend it to all sorts of Problems, and for this end proposed the making of a general Table of Tangents; and therefore had not yet found out the true Improvement. But about half a Year after, when he was newly fallen upon the true Improvement, he wrote back; *Clariss. Slusii Methodum Tangentium nondum esse absolutam Celeberrimo Newtono assentior. Et jam A MULTO TEMPORE rem Tangentium generalius tractavi, scilicet per differentias Ordinatarum.* Which is as much as to say that he had this Improvement long before those Days. It lies upon him, in point of Candor, to make us understand that he pretended to this Antiquity of his Invention with some other Design than to rival and supplant Mr. Newton, and to make us believe that he had the Differential Method before Mr. Newton explained it to him by his Letters of June 13. and Octob. 24. 1676, and before Mr. Oldenburgh sent him a Copy of Mr. Newton's Letter of Decem. 10. 1672 concerning it.

The Editors of the *Acta Eruditorum* in June 1696, in giving an Account of the two first Volumes of the Mathematical Works of Dr. Wallis, wrote thus, in the Style of Mr. Leibnitz. *Caterum ipse Newtonus, non minus Candore quam præclaris in rem Mathematicam meritis insignis, publice &*

privatim agnovit Leibnitium, tum cum (interveniente celeberrimo Viro Henrico Oldenburgo Bremensi, Societatis Regiæ Anglicanæ tunc Secretario) inter ipsos (ejusdem jam tum Societatis Socios) commercium intercederet, id est jam fere ante annos viginti & amplius, Calculum suum differentialem, Seriesque infinitas, & pro iis quoque Methodos generales habuisse; quod Wallisius in Prefatione Operum, facta inter eos communicationis mentionem faciens, præterit, quoniam de eo fortasse non satis ipsi constabat. Caterum Differentiarum consideratio Leibnitiana, cujus mentionem facit Wallisius (ne quis scilicet, ut ipse ait, causeretur de Calculo Differentiali nihil ab ipso dictum fuisse) meditationes apernit, quæ aliunde non æque nascebantur, &c. By the Words here cited out of the Preface to the two first Volumes of Dr. Wallis's Works, it appears that Mr. Leibnitz had seen that Part of the Preface, where Mr. Newton is said to have explained to him (in the Year 1676) the Method of Fluxions found by him Ten Years before or above. Mr. Newton never allowed that Mr. Leibnitz had the Differential Method before the Year 1677. And Mr. Leibnitz himself in the *Acta Eruditorum* for April 1691. pag. 178. acknowledged that he found it after he returned home from Paris to enter upon Business, that is, after the Year 1676. And as for his pretended general Method of infinite Series, it is so far from being general, that it is of little or no use. I do not know that any other Use hath been made of it, than to colour over the Pretence of Mr. Leibnitz to the Series of Mr. Gregory for squaring the Circle.

Mr. Leibnitz, in his Answer to Mr. Fatio printed in the *Acta Eruditorum* for the Year 1700. pag. 203. wrote thus. Ipse [Newtonus] scit unus omnium optime, satisque indicavit publice cum sua Mathematica Naturæ Principia publicaret, Anno 1687, nova quadam inventa Geometrica, quæ ipsi communia mecum fuere, NEUTRUM LUCI AB ALTERO ACCEPTE, sed meditationibus quemque suis debere, & a me decennio ante [i. e. anno 1677] exposita fuisse. In the

Book of *Principles* here referred unto, Mr. *Newton* did not acknowledge that Mr. *Leibnitz* found this Method without receiving Light into it from Mr. *Newton's* Letters above-mentioned; and Dr. *Wallis* had lately told him the contrary without being then confuted or contradicted. And if Mr. *Leibnitz* had found the Method without the Assistance of Mr. *Newton*, yet second Inventors have no Right.

Mr. *Leibnitz* in his aforesaid Answer to Mr. *Fatio*, wrote further: *Certe cum elementa Calculi mea edidi anno 1684, ne constabat quidem mihi aliud de inventis ejus [sc. Newtoni] in hoc genere, quam quod ipse olim significaverat in literis, posse se Tangentes invenire non sublati irrationalibus, quod Hugenius quoque se posse mihi significavit postea, etsi caterorum ejus Calculi adhuc expers. Sed majora multo consecutum Newtonum, viso demum libro Principiorum ejus, satis intellexi.* Here he again acknowledged that the Book of *Principles* gave him great Light into Mr. *Newton's* Method: and yet he now denies that this Book contains any thing of that Method in it. Here he pretended that before that Book came abroad he knew nothing more of Mr. *Newton's* Inventions of this kind, than that he had a certain Method of Tangents. and that by that Book he received the first Light into Mr. *Newton's* Method of Fluxions: but in his Letter of June 21. 1677 he acknowledged that Mr. *Newton's* Method extended also to Quadratures of curvilinear Figures, and was like his own. His Words are; *Arbitror quæ celare voluit Newtonus de Tangentibus ducendis ab his non abluere. Quod addit, ex hoc eodem fundamento Quadraturas quoque reddi faciliores me in sententia hac confirmat; nimirum semper figura illa sunt quadrabiles quæ sunt ad æquationem differentialem.*

Mr. *Newton* had in his three Letters above-mentioned (copies of which Mr. *Leibnitz* had received from Mr. *Oldenberg*) represented his Method so general, as by the Help of Equations, finite and infinite, to determin *Maxima* and *Minima*, Tangents, Areas, solid Contents, Centers of Gravity, Lengths

**Lengths and Curvities of curve Lines and curvilinear Figures,** and this without taking away Radicals, and to extend to the like Problems in Curves usually called Mechanical, and to inverse Problems of Tangents and others more difficult, and to almost all Problems, except perhaps some Numeral ones like those of *Diophantus*. And Mr. *Leibnitz* in his Letter of *Aug. 27 1676*, represented that he could not believe that Mr. *Newton's* Method was so general: Mr. *Newton* in the First of his three Letters set down his Method of Tangents deduced from this general Method, and illustrated it with an Example, and said that this Method of Tangents was but a Branch or Corollary of his General Method, and that he took the Method of Tangents of *Slusius* to be of the same kind : and thereupon Mr. *Leibnitz*, in his Return from *Paris* through *England* and *Holland* into *Germany*, was considering how to improve the Method of Tangents of *Slusius*, and extend it to all sorts of Problems, as we shewed above out of his Letters. And in his third Letter Mr. *Newton* illustrated his Method with Theorems for Quadratures and Examples thereof. And when he had made so large an Explanation of his Method, that Mr. *Leibnitz* had got Light into it, and had in his Letter of *June 21. 1677* explained how the Method which he was fallen into answered to the Description which Mr. *Newton* had given of his Method, in drawing of Tangents giving the Method of *Slusius*, proceeding without taking away Fractions and Surds, and facilitating Quadratures ; for him to tell the *Germans* that in the Year 1684, when he first published his Differential Method, he knew nothing more of Mr. *Newton's* Invention, than that he had a certain Method of Tangents, is very extraordinary and wants an Explanation:

At that time he explained nothing more concerning his own Method, than how to draw Tangents and determine *Maxima* and *Minima* without taking away Fractions or Surds. He certainly knew that Mr. *Newton's* Method would do all  
this

this, and therefore ought in Candor to have acknowledged it. After he had thus far explained his own Method, he added that what he had there laid down were the Principles of a much sublimer Geometry, reaching to the most difficult and valuable Problems, which were scarce to be resolved without the Differential Calculus, *AUT SIMILI*, or another like it. What he meant by the Words *AUT SIMILI* was impossible for the *Germans* to understand without an Interpreter. He ought to have done Mr. *Newton* justice in plain intelligible Language; and told the *Germans* whose was the *Methodus SIMILIS*, and of what Extent and Antiquity it was, according to the Notices he had received from *England*; and to have acknowledged that his own Method was not so ancient. This would have prevented Disputes, and nothing less than this could fully deserve the Name of Candor and Justice. But afterwards, in his Answer to Mr. *Fatio*, to tell the *Germans* that in the Year 1684, when he first published the Elements of his Calculus, he knew nothing of a *Methodus SIMILIS*, nothing of any other Method than for drawing Tangents, was very strange and wanted an Explanation.

It lies upon him also to satisfy the World why, in his Answer to Dr. *Wallis* and Mr. *Fatio*, who had published that Mr. *Newton* was the oldest Inventor of that Method by many Years, he did not put in his Claim of being the oldest Inventor thereof, but staid till the old Mathematicians were dead, and then complained of the new Mathematicians as Novices; attacked Mr. *Newton* himself, and declined to contend with any Body else, notwithstanding that Mr. *Newton* in his Letter of *Octob.* 24. 1676 had told him, that for the sake of Quiet, he had Five Years before that time laid aside his Design of publishing what he had then written on this Subject, and has ever since industriously avoided all Disputes about Philosophical and Mathematical Subjects, and all Correspondence by Letters about those Matters, as tending to Dis-

putes; .

putes ; and for the same Reason has forbore to complain of Mr. *Leibnitz*, untill it was shewed him that he stood accused of Plagiarism in the *Acta Lipsie*, and that what Mr. *Keill* had published was only in his Defence from the Guilt of that Crime.

It has been said the Royal-Society gave judgment against Mr. *Leibnitz* without hearing both Parties. But this is a Mistake. They have not yet given judgment in the Matter. Mr. *Leibnitz* indeed desired the Royal-Society to condemn Mr. *Keill* without hearing both Parties ; and by the same sort of Justice they might have condemned Mr. *Leibnitz* without hearing both Parties ; for they have an equal Authority over them both. And when Mr. *Leibnitz* declined to make good his Charge against Mr. *Keill*, the Royal-Society might in justice have censured him for not making it good. But they only appointed a Committee to search out and examin such old Letters and Papers as were still extant about these Matters, and report their Opinion how the Matter stood according to those Letters and Papers. They were not appointed to examin Mr. *Leibnitz* or Mr. *Keill*, but only to report what they found in the ancient Letters and Papers : and he that compares their Report therewith will find it just. The Committee was numerous and skilful and composed of Gentlemen of several Nations, and the Society are satisfied in their Fidelity in examining the Hands and other Circumstances, and in printing what they found in the ancient Letters and Papers so examined, without adding, omitting or altering any thing in favour of either Party. And the Letters and Papers are by order of the Royal-Society preserved, that they may be consulted and compared with the *Commercium Epistolicum*, whenever it shall be desired by Persons of Note. And in the mean time I take the Liberty to acquaint him, that by taxing the Royal-Society with Injustice in giving Sentence against him without hearing both Parties, he has transgressed one of their Statutes which makes it Expulsion to defame them.

The Philosophy which Mr. *Newton* in his *Principles* and *Optiques* has pursued is Experimental; and it is not the Business of Experimental Philosophy to teach the Causes of things any further than they can be proved by Experiments. We are not to fill this Philosophy with Opinions which cannot be proved by Phænomena. In this Philosophy Hypotheses have no place, unless as Conjectures or Questions proposed to be examined by Experiments. For this Reason Mr. *Newton* in his *Optiques* distinguished those things which were made certain by Experiments from those things which remained uncertain, and which he therefore proposed in the End of his *Optiques* in the Form of Queries. For this Reason, in the Preface to his *Principles*, when he had mention'd the Motions of the Planets, Comets, Moon and Sea as deduced in this Book from Gravity, he added: *Utinam cetera Naturæ Phænomena ex Principiis Mechanicis eodem argumentandi genere derivare liceret. Nam multa me movent ut nonnihil suspicer ea omnia ex viribus quibusdam pendere posse, quibus corporum particula per causas nondum cognitæ vel in se mutuo impelluntur & secundum figuras regulares coherent, vel ab invicem fugantur & recedunt: quibus viribus ignotis Philosophi hætenus Naturam frustra tentarunt.* And in the End of this Book in the second Edition, he said that for want of a sufficient Number of Experiments, he forbore to describe the Laws of the Actions of the Spirit or Agent by which this Attraction is performed: And for the same Reason he is silent about the Cause of Gravity, there occurring no Experiments or Phænomena by which he might prove what was the Cause thereof: And this he hath abundantly declared in his *Principles*, near the Beginning thereof, in these Words; *Virium causas & sedes Physicas jam non expendo.* And a little after: *Voces Attractionis, Impulsus, vel Propensionis cujuscunque in centrum indifferenter & pro se mutuo promiscue usurpo, has Vires non Physice sed Mathematicæ tantum considerando. Unde caveat Lector ne per hujusmodi voces cogitet me*  
*speciem.*



*speciem vel modum actionis, causamve aut rationem physicam alicubi definire, vel Centris (quæ sunt puncta Mathematica) vires verè & physicè tribuere, si forte aut Centra trahere aut vires Centrorum esse dixerò.* And in the End of his Opticks : *Qua causa efficiente hæc attractiones [sc. gravitas, visque magnetica & electrica] peragantur, hic non inquirò. Quam ego Attractionem appello, fieri sane potest ut ea efficiatur impulsu vel alio aliquo modo nobis incognito. Hanc vocem Attractionis ita hic accipi velim ut in universum solummodo vim aliquam significare intelligatur quæ corpora ad se mutuo tendant, cuicumque demum causæ attribuenda sit illa vis. Nam ex Phænomenis Naturæ illud nos prius edoctos oportet quæ iam corpora se invicem attrahant, & quænam sint leges & proprietates istius attractionis, quam in id inquirere par sit quænam efficiente causa peragatur attractio.* And a little after he mentions the same Attractions as Forces which by Phænomena appear to have a Being in Nature, tho' their Causes be not yet known; and distinguishes them from occult Qualities which are supposed to flow from the specifick Forms of things. And in the Scholium at the End of his Principles, after he had mentioned the Properties of Gravity, he added : *Rationem vero harum Gravitatis proprietatum ex Phænomenis nondum potui deducere, & Hypotheses non fingò. Quicquid enim ex Phænomenis non deducitur Hypothesis vocanda est; & Hypotheses seu Metaphysicæ seu Physicæ, seu Qualitatum occultarum, seu Mechanicæ, in Philosophia experimentalis locum non habent. — satis est quod Gravitatis revera existat & agat secundum leges à nobis expositas, & ad Corporum cælestium & Maris nostri motus omnes sufficiat.* And after all this, one would wonder that Mr. Newton should be reflected upon for not explaining the Causes of Gravity and other Attractions by Hypotheses; as if it were a Crime to content himself with Certainities and let Uncertainties alone. And yet the Editors of the *Acta Eruditorum*, (a) have told the World that Mr. Newton denies that the cause of Gravity is Mechanical, and that if the Spirit or Agent by which Electrical Attraction is performed, be not the *Ether* or *subtile Matter* of *Cartes*, it is less valuable than an Hypothesis, and perhaps may be the Hylarchic Principle of Dr. *Henry Moor*: and Mr. *Leibnitz* (b) hath accused him of making Gravity a natural or essential Property of Bodies, and an occult Quality and Miracle. And by this sort of Railery they are perswading the *Germans* that Mr. Newton wants Judgment, and was not able to invent the Infinitesimal Method.

(a) Anno 1714, mense Martio, p. 141. 142. (b) In tractatu de Bonitate Dei & in Epistolis ad D. Hartsoecker & alibi.

It must be allowed that these two Gentlemen differ very much in Philosophy. The one proceeds upon the Evidence arising from Experiments and Phænomena, and stops where such Evidence is wanting; the other is taken up with Hypotheses, and propounds them, not to be examined by Experiments, but to be believed without Examination. The one for want of Experiments to decide the Question, doth not affirm whether the Cause of Gravity be Mechanical or not Mechanical: the other that it is a perpetual Miracle if it be not Mechanical. The one (by way of Enquiry) attributes it to the Power of the Creator that the least Particles of Matter are hard: the other attributes the Hardness of Matter to conspiring Motions, and calls it a perpetual Miracle if the Cause of this Hardness be other than Mechanical. The one doth not affirm that animal Motion in Man is purely mechanical: the other teaches that it is purely mechanical, the Soul or Mind (according to the Hypothesis of an *Harmonia Præstabilita*) never acting upon the Body so as to alter or influence its Motions. The one teaches that God (the God in whom we live and move and have our Being) is Omnipresent; but not as a Soul of the World: the other that he is not the Soul of the World, but *INTELLIGENTIA SUPRAMUNDANA*, an Intelligence above the Bounds of the World; whence it seems to follow that he cannot do any thing within the Bounds of the World, unless by an incredible Miracle. The one teaches that Philosophers are to argue from Phænomena and *Experiments* to the Causes thereof, and thence to the Causes of those Causes, and so on till we come to the first Cause: the other that all the Actions of the first Cause are Miracles, and all the Laws impressed on Nature by the Will of God are perpetual Miracles and occult Qualities, and therefore not to be considered in Philosophy. But must the constant and universal Laws of Nature; if derived from the Power of God or the Action of a Cause not yet known to us, be called Miracles and occult Qualities, that is to say, *Wonders* and *Absurdities*? Must all the Arguments for a God taken from the Phænomena of Nature be exploded by *new hard Names*? And must Experimental Philosophy be exploded as *miraculous* and *absurd*, because it asserts nothing more than can be proved by Experiments, and we cannot yet prove by Experiments that all the Phænomena in Nature can be solved by meer Mechanical Causes? Certainly these things deserve to be better considered.

# PHILOSOPHICAL TRANSACTIONS.

For the Months of *March, April and May, 1715.*

## The CONTENTS.

- I. *D. Gothofredi Kirchii Astronomi & Observatoris præstantissimi, & Societatis Regiæ Berolinensis dum vixit Socii, De varia apparentia Stellæ Novæ in Collo Cygni Narratio: è Miscellaneis Berolinensibus anno MDCCX editis desumpta. pag. 208.*
- II. *Botanicum Hortense IV. Giving an Account of divers Rare Plants, Observed the last Summer A. D. 1714. in several Curious Gardens about London, and particularly the Society of Apothecaries Physick Garden at Chelsea. By James Petiver, F. R. S.*
- III. *Observations of the late Total Eclipse of the Sun on the 22d of April last past, made before the Royal Society at their House in Crane-Court in Fleet-Street, London. By Dr. Edmund Halley, Reg. Soc. Secr. With an Account of what has been communicated from abroad concerning the same.*
- IV. *An Account of a Book. Bibliographiæ Anatomicæ Specimen, sive Catalogus omnium pene Auctorum, qui ab HIPPOCRATE ad HARVEIUM Rem Anatomicam ex professo vel obiter scriptis illustrarunt, &c. Curâ & studio JACOBI DOUGLAS, M. D. Reg. Soc. Sod. & in Colleg. Chirurg. Londinensi, Prælect. Anatom. 8vo. Londini, 1715.*

- I. D. Gothofredi Kirchii *Astronomi & Observatoris præstantissimi, & Societatis Regiæ Berolinensis dum vixit Socii, De varia apparentia Stellæ novæ in Collo Cygni Narratio: è Miscellaneis Berolinensibus anno MDCCX editis desumpta.* pag. 208.

Quaquam multæ varietates mutationesque inter stellas fixas, quoad apparentem earum magnitudinem in cælo contingant, nulla tamen inter omnes mutabilis apparentiæ stellas fixas mirabiliq; habita est, illâ quam *Fabricius* Anno 1596. in collo Ceti primus observavit. Licet enim primò pro ejusmodi nova Stella habita fuerit quæ nunquam antea extiterit, & postquam disparuit non amplius esset reditura: nunc tamen experientia satis comprobavit eam constanter existere, & absque omni dubio à principio mundi in eo loco, quem nunc quoque obtinet, existisse. Hoc solummodo in ea mirandum, quod sese quotannis in varia magnitudine spectandam exhibeat, & plerumque certis temporibus nudis oculis plane videri nequeat; qua de causa etiam a Domino *Hevelio* Stella Mira vocata est.

Aliam huic similem ego quoque in collo Cygni deprehendi, multo autem minorem, & quotannis breviori spatio temporis conspiciendam. Unde mirum non est eam tamdiu incognitam mansisse: Imo pro singulari felicitate reputandum, quod eo ipso tempore visibilis fuerit, ac in sua maxima magnitudine apparuerit, quo *Bayerus* stellas in Cygno considerabat & delineabat, ubi eam notâ  $\chi$  designavit, & inter constanter apparentes fixas 5<sup>ta</sup> magnitudinis recensuit. Quemadmodum etiam supra memoratam in collo Ceti, cum hocce Sydus consideraret & delinearet, in quarta magnitudine deprehendit & literâ  $\theta$  designavit, eam-

eamque pro constanter apparente Stella fixa habuit.

Ut mutabilem apparentiam stellæ  $\chi$  in collo Cygni deprehenderem, occasionem dedit stella capiti Cygni vicina, quam *Hevelius*, Astronomus solertissimus, Anno 1670 & 71. observavit. Cum enim spem conciperem fore ut eadem stella nunc iterum sæpius esset apparitura, non secus ac stella in collo Ceti, quam *Hevelius* post primam disparitionem mox iterum apparuisse constabat, quærebam eam  $1^{\circ}$  &  $6^{\circ}$  ( $11^{\circ}$  &  $16^{\circ}$ ) Julii 1686. noctibus serenis, non autem reperiēbam; sed potius animadvertebam stellam illam  $5^{\text{ta}}$  magnitudinis in collo Cygni, à *Bayero* græca litera  $\chi$  signatam, desiderari. Die vero 9 (19.) Octobris deprehendi eam nudis oculis distinctè omnino. Et quia facile adducebar ut existimarem eandem nudis nostris oculis iterum disparituram, delineavi aliquot ipsam circumstantes stellulas, ope bipedalis magnæque capacitatis Tubi, ut ex harum cum illa comparatione magnitudinem ejus, cum decrederet, expenderem, uti Fig. A. exhibetur.

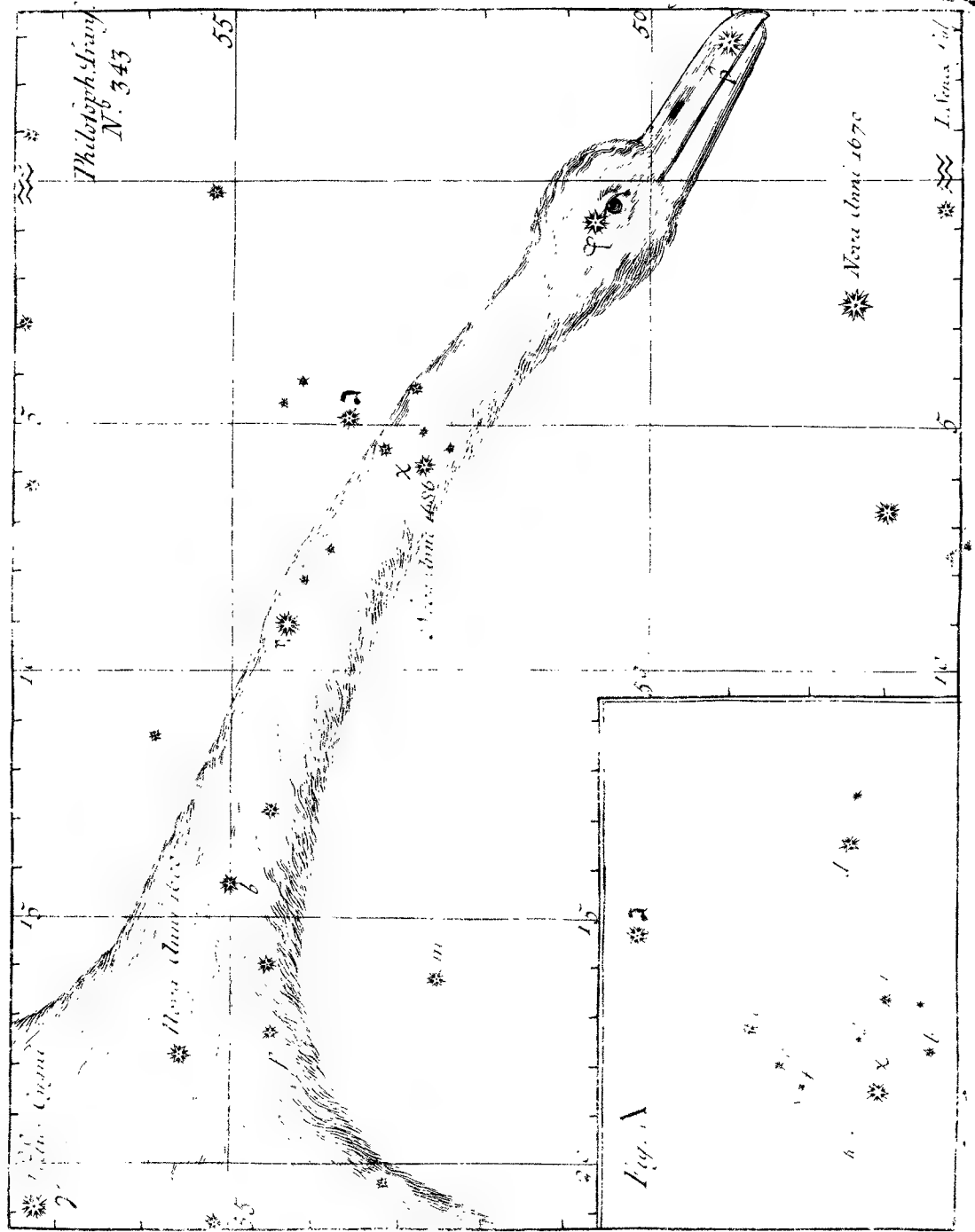
Deprehensum est quoque, stellam istam paulatim decrevisse, donec eam Tubo 8 pedum non potuerim amplius assequi, cum tamen aliam illam in collo Ceti, quando nudo oculo non amplius patet, per tubum 4 pedum semper dignoscere possim.

Ab illo tempore quærebam quidem stellam istam variis noctibus frustra, tandem verò tamen eam reperi  $6^{\circ}$  ( $16^{\circ}$ ) Aug. 1687. iterum ope octopedalis Tubi, at vero exiguam valde. Inde de die in diem crevisse deprehendebatur; & factum est, ut die 23 Octob. (2 Novemb.) iterum primâ vice, nudo oculo, se se conspiciendam præberet, valde licet adhuc dum exiguam. Die 2<sup>da</sup> ( $12^{\circ}$ ) Nov. optime erat conspicua, etiam post 26<sup>um</sup> Nov. (6. Dec.) ut ut hoc ultimo die jam iterum in statu decrescendi existeret. Postmodum non nisi per Tubos dignosci potuit, tandemque adeò exigua evasit, ut iterum Tubo 8 pedum eam deprehendere non potuerim. Atque ita animadversum est hac vice, ab

una disparitione usque ad alteram, annum unum, mensem unum, unamque hebdomadam circiter effluxisse. Sequentes quoque observationes docuerunt hanc stellam tempus satis constans in sua apparitione servare, non tamen quavis vice ad æqualem magnitudinem pervenire. Imo aliquando accidit, ut nudo oculo planè invisibilis maneat, dum per Tubum est conspicua, & maximam suam magnitudinem assecuta est; prout Anno 1688 in fine, & 1689 in principio anni accidit. E contrario, sequente anno 1690, stella hæc eo melius videri poterat, & quidem notabiliter major quam sua vicina, quam *Bayerus* juxta  $\chi$  collocavit extra collum Cygni, nullaque literâ notavit, quam ego solius memoriæ juvandæ gratia, Hebraica litera א notavi. Et postquam hujus stellæ apparentiam & disparentiam sæpius observavi, comperi eam valde esse regularem, revolutionemque 404 $\frac{1}{2}$  dierum servare.

*Cum* Miscellanea Berolinensia, *serius ad nos perlata sint, non ante annum ultimo elapsum hanc Stellam novam secundum D. Kirchii monitum conspeximus; idque juxta Idus Julii, st. vet. cum multo clarior quam vicina א, ac fere aqualis media in collo Cygni (Bayero  $\eta$ ) apparuit: sed post mensem nudis oculis inconspicua facta, tandem etiam Telescopio evanuit. Juxta periodum qua revolvitur dicitur, mense saltem Augusto currentis anni 1715. maximam suam claritatem adipisci debet: unde curiosis siderum scrutatoribus de hacre sat sane notabili certa capi poterint documenta.*

*Ut autem facilius in Cælo inveniatur, duo Schemata adjecimus, quorum alterum exhibet Cygni collum, cum Fixis huic Novæ adjunctis, Novisque duabus aliis intra seculum in ejus vicinia emergis; quarum quæ ante Pectus Cygni etiamnum conspicitur quasi quinti honoris: quæ vero sub Capite per biennium tantum visa hætenus latet. Altera Figura, quæ est Kirchii A, Telescopicas Novæ proximæ demonstrat, ut sciatur quo præcise loco primum redeantis radium jeculi Cælestices Tubo armati præstolari debeant.*



---

 II. B O T A N I C U M Hortense I V.

*Giving an Account of divers Rare Plants, Observed the last Summer A. D. 1714. in several Curious Gardens about London, and particularly the Society of Apothecaries Physick-Garden at Chelsea.*  
By James Petiver, F. R. S.

## S E C T I. E U R O P E A N Plants.

1. **V**alentia Knotgrass. Ray's *English Herball* Tab. x. fig. 8.

*Anthyllis Valentina* Clus. *Hist.* 186. c. 9. Fig. *id.* Hisp. 480. Fig. *Park.* 446. fig. 3.

*Anthyllis maritima*, *Chamaelyce* similis CB. 282. 1. *Phyt.* 552. 1.

*Anthyllidis* species quibusdam *Chabr.* 452.  *Ic.* 5. I. B. Vol. 3. L. 29. p. 374. Fig.

This is a low spreading Ground Plant, with roundish small *Leaves*, and very little four leaved bluish *Flowers*.

Dr. *John Placa* M. D. and publick Professor of *Valentia*, first observed this Plant about the Ditches of that City, and there shewed it to that accurate Botanist *Carolus Clusius* who has given us a very good Figure of it.

Dr. *Magnol* hath also found it on the Coasts of *Languedock*.

Mon<sup>r</sup>. *Riqueur* Apothecary to the late *Queen* of Spain, sent me the Seed of this and many other curious Plants, which he collected about *Madrid*, several of which were the last Summer raised in our *Physick Garden* at *Chelsea*, where this *Flowered*.



2. Annual Fleawort. Ray *Hist. Plant.* 881. 1.

*Psyllium majus erectum* C B pin. 191. 3. alterum C B phyt. 353. 2.

*Psyllium* five *Pulicaris* Herba Ger. 471. fig. 1. *Fonst.* 587. fig. 1.

*Pulicaris* Herba *Lobel.* Icon. 436. 2. *id.* Belg. 523. Obs. 239.

Its Top Branches and Stalks are somewhat fat or clammy, its Leaves are like *Hyssop* and broader than the *Perennial*. Grows plentifully in the Fields about *Montpelier*.

3. Notcht leaved Fleawort. Ray H. Pl. 882. 2.

*Psyllium Dioscoridis* five *Indicum* foliis crenatis C.B. 199. 1. prodr. 99. 1.

*Psyllium Indicum* foliis crenatis *Park.* 277. 3.

*Psyllium laciniatis* foliis *Bocc.* 8. Tab. 4.

This differs from the common *Annual*, only in having notcht or indented Leaves.

4. Perennial Fleawort Ray 882. 3.

*Psyllium Camer.* Epit. 811. Fig. *Chabr.* 501, Ic. 3. I B. 3. l. 31. p. 513. fig.

*Psyllium majus supinum* C. B. 191. 2. majus C. B. phyt. 353. 1.

*Psyllium maj.* sempervirens *Park.* 277. 2. & vulg. 278. *secund.* Fig.

*Psyllium Plinianum* fortè, *radice* perenni, *supinum* *Lobel.* Icon 437. 1. *id.* Belg. 523. *id.* Obs. 239. fig.

Grows frequently in *Italy* and about *Montpelier*.

*Vertues.* The Seed of this Plant evacuates yellow Choler, and by its Mucilage, blunts the Acrimony of the Humors, and is therefore commended in Dysenteries and other Corrosions of the Gutts.

Dr. *Sloane* has experienced it in Excoriations of the Uvula or Palat, and where the Tongue is parcht.

*H. Reusnerus* says a Mucilage of its Seeds, in *Rose-water* with *Vinegar*, has cured great Pains in the Head. proceeding from a Hot Cause, when other Medicines have failed.

The

The same with *Camphire* has been successfully applied to inflamed Eyes.

5. Maple *Blite*. Ray's English Herbal Tab. 8. Fig. 7. *Atriplex* odore & folio *Datura*, minori ramem, *Triumphet*. 65.

Blitum *Aceri*; folio *Cat.* Herbar. *Britan.* Tab. 8. fig. 7. Blitum seu *Atriplex* *Pes Anserinus* dicta, *Stramonii* acutiore folio ramosum *Fluk. Mantif.*

*Chenopodio* affinis, folio lato laciniato in longissimum mucronem procurrente, florum racemis sparsis Ray H Pl. Vol. 3. p. 123.

Mr. *Dale* was the first that observed this in *England*, viz. about *Colchester*, I find it the same with that of *Triumphetti*, a Specimen of it being lately sent me from *Peter Antony Micheli* Botanist to his Royal Highness the Duke of *Florence*.

6. Thorney *Burnett* Ray 1492. cap. 7.

*Pimpinella* spinosa *Park* 998. fig.

*Poterion* *Lob.* Ic. T. 2. p. 26 Fig. 2. *Belg.* 2. p. 30. Obs. 491. fig.

*Poterion* *Lob.* five *Pimpinella* spinosa C B. 388. 2.

*Poterio* affinis folio *Pimpinella*, spinosa C B. 382. 2.

*Ramolph* first observed this Plant on the Sides of *Mount Libanus*, and from whom all our Figures are copied.

*Dalechamp* has since found it in the *Valleys* about *Marra* near *Gratiarople* in *Dauphiny*.

*Honorius Bellus* a learned Physician in *Candy*, says the Rusticks of that Island make a Tea of this Plant, which cures them of all Sorts of Fluxes.

Its called *Stoibeda* in most parts of *Greece*.

7 Blew *Cat-Succory* Ray 257. c. 6.

*Catanance* *Dalech.* fl. *Cyani*, fol. *Coronopi* *Chabr.* 342. Ic. opt. 2. I. B. 3. l. 25. p. 26. Fig.

*Chondrilla* *Sesamoides* dicta *Park* 186 fig. 5.

*Chondrilla* *Sesamoides* dicta cærulea C B phyt. 217. 14.

*Chondrilla* cærulea, *Cyani* capitulis C B. 131. 6.

*Sesamoides* parvum. *Matth Ger.* 397. Ic. 4. *Jonst.* 493. fig. 3.

Its blew *Succory*-like *Flowers*, with narrow dented *Leaves* distinguish it from all others. Grows

Grows very common near *Narbonne*, and in *Savoy* on dry stony Hills.

I gathered this elegant Plant in *Flower* this Summer in His Majesty's Gardens at *Hampton Court*, under the care of Mr. *Wife*, King *George's* Gardiner.

8. Yellow Cat-Succory.

*Catanance Cretica* fl. luteo.

*Stæbe Plantaginis folio.* *Alpin.* *Exot.* 286. fig. *Park.* 477. fig. 7.

*Stæbe Plantaginis folio*, fl. luteo *H.Oxon.* Vol. 2. p. 137. 4.

Mr. *Jacob Bobart* Botanick Professor at *Oxford*, sent me the first Specimen of this, which has lately Flowred very well with us in *Chelsea* Garden.

9. Sea Ragwort. Ray 286. 6.

*Jacobeæ marina* *Jonst.* 280. Ic. 4. C B. *phyt.* 218. 1.

*Jacobeæ marina* five *Cineraria* *Chabr.* 330. Ic. 6. 1. B. 2. L. 24. p. 1056. fig.

*Jacobeæ marina* five *Cineraria* vulg. *Park.* 669. fig. 7.

*Jacobeæ maritima* C B. 131. 3.

This has been long cultivated as a great Ornament in Gardens.

*Vertues.* *Alpinus* says the *Ægyptians* use this as a very sovereign Plant, drinking a Tea of it for the Stone, and to open Obstructions of the Bowels and Womb.

Grows on the Coasts of *Tuscany*.

10. Sicilian Ragwort. Ray 286. 9.

*Jacobeæ Sicula Chrysanthemi facie* *Bocc.* 66. Tab. 36.

It leaves like our *Corn Marygold*, flowers in *Chelsea* Garden even till *Christmas*. Grows wild about *Catania*, &c.

11. Common Narrow *Cassidony* Ray 281. 4.

*Elychryson* five *Stachas citrina angustifolia* C B. 264. 4. vel *Gallica* *phyt.* 513. 4.

*Chrysocome* vulg 1. *Clus.* 326. fig.

*Chrysocome media*, f. *Stachas citrina* vulg. *Barrelier.* 974. Ic. 409.

*Stachas*

*Stachas Citrina* Dod. 268.

*Stachas citrina* five *Amaranthus luteus* Jonst. 646. Ic. 1.

*Stæchas citrina* five *Coma aurea* Park. 68. fig. 7.

*Stachas citrina*, *tenuifolia Narbonensis* I B. 3. l. 26. p. 154.  
fig. ead. flore luteo palleſcente Chabr. 369. Ic. 5.

The Leaves of this Plant are beſt represented in I B. and *Chabreus*, being much narrower than thoſe *Figured* by *Cluſius*.

Grows plentifully about *Montpelier*, where it *Flowers* in *April* and *May*.

12. Candy *Caffidony*, Ray 282. 8.

*Elychryſum Creticum* C B. 264. 6.

*Chryſocome* 5 quæ *Cretica* Cluſ. 327.

*Chryſocome* five *Stachas citrina Cretica* Park. 69. 8.

*Stachas citrina globoſo* & amplo flore *Cretica*, Barrelier pl. 987. Ic. opt. 814.

This laſt Author has given a very accurate Figure of this Plant, which is ſo beautiful an Ornament in our moſt curious Gardens.

13. Stif-rim'd *Mary-gold*, Ray 338 c. 4. pl. 2.

*Aſter Atticus Caſalp.* 495. c. 30. *Ger.* 392. Ic 1. *Jonſt.* 486. Ic. 1.

After *Atticus* 1. Cluſ. 13. Fig. 1. *Maſſiloticus Tabern.* Icon. 361. 2.

After *Att. luteus vulg.* Park. 128. fig. 1.

After *Atticus* & *Inguinaria* ſ. *Inguinalis* Lob. Ic. 348. 2. Belg. 423. Obſ. 188. fig.

After *luteus*, foliis ad florem rigidis C B. 266. 1. *Phyt.* 518. 1.

*Chryſanthemum Aſteris* facie, foliis ad florem rigidis H. Leyd 144.

Its Rim of yellow Flowers is beſet with ſtiff, long, pointed green Leaves, by which its diſtinguiſhed from all others.

Its common in *Sicily*, *Italy*, *Narbon* and *Spain*, Flowring in *May* and *June*.

14. *Bobart's Venice Chamomil* Ray 3. p. 223. 15.  
*Cotula Veneta Sophiae folio Nobis.*  
*Chamamelum* annum ramofum *Cotulae fatide* fol. ampliori-  
 bus capitulis spinofis *Bob. H. Ox.* 3. p. 36. 12. *Seet.*  
 VI. Tab. 8. fig.

We are obliged to Mr. *Jacob Bobart* for the first Know-  
 ledge of this Plant.

15. *Distaff-Thistle* Ray 304. 4.  
*Atractylis Offic.* Dale 168. 3. *Ger.* 1008. Ic. 1. *Jonst.* 1171.  
 Ic. 1.

*Atractylis lutea* C. B. 379. 1. fl. luteo *Park.* 963. Ic. 1.  
*Atractylis veterum* f. vera, fl. luteo *Chabr.* 353. Ic. 4. I B. 3. 1.  
 25. p. 85. fig.

*Atractylis Theophrasti* & *Diosc.* sanguineo succo *Col.* 19.  
 fig. 23.

Mr. *Ray* has given a large *Description* of this *Thistle* p.  
 304. from the accurate *Columna*, and it is remarkable for  
 its bloody Juice.

Its said to have the same *Vertues* with the *Carduus Bene-*  
*dictus*

Grows in *France*, *Spain* and *Italy* as also about *Geneva* in  
 Path-ways and Borders of Fields.

16. Cobweb *Distaff-Thistle.*  
*Atractylis ramulis araneosis.*  
 an *Chameleon niger* verus *Park?*

This differs from the *Distaff-Thistle* in having its upper  
 Stalks woolly like *Cobwebs*. It was many Years since raised  
 in Mr. *Charles Dubois* his Garden at *Mitcham*, from Seed I  
 gave him brought me by Mr. *Samuel Daniel*, Surgeon, from  
 the *Island Coos*.

17. *Clusius* his *Salamanca* Welshed Thistle, Ray 315.  
*Acarna major* caule folioso C B. 379. 6. *Park.* 966. f. 6.  
*Acarnae* similis fl. purp. *Chameleon* *Salmant* *Clus.* 1. B. 3. 1.  
 25. p. 91 fig. *Chabr.* 155. Ic. 6  
*Chameleon Salmanticensis* *Clus. Hist.* 155. f. 1. *Jonst.* 1160.  
 fig. 2. *Clusius*

*Clusius* first observed this about *Salamanca* in *Spain*, it hath since been found in *Languedoc* and other places.

18. *Theophrastus* his *Fish Thistle* Ray 315. 4. Dale

Suppl. 74. 4.

*Acarina Theophrasti* Ger. 1012. fig 7 Jonst. 1175. f. 7.

*Acarina di Theophrasto* Imperati 669. fig. opt.

*Acarina major* caule non folioso C. B. 273. 7. Park 966. f. 7.

*Acarina Theophr.* Imperati *Ilvensis* f. *Italica* Barrel. 912. Ic. 1211.

*Acarina similis*, *Carduus polyacanthus* Chabr. 356. Ic. 2.

*Polyacanthus* *Causabona* *Acarina* similis l. B. 3. l. 25. p. 92. fig.

*Imperatus* his *Figure*, which *Barrelier* has copied, very well represents this elegant *Thistle*. *Chabr* & l. B. are also better than *Lobel's*, which *Park.* and most others have followed.

Grows on the Hills, North of *Rio* near the Iron Mines in the Island of *Ilva*.

19. Dwarf *Narbonne* Artichoke. Ray 329. 29.

*Centaureum majus incanum humile*, cap. *Pini*. El. Bot. 355.

*Instit.* 449.

*Chameleon non aculeatus* Lob. Ic. p. 2. p. 7. Ad. 367. fig.

*Facea montana incana* *Pini* capite C. B. 272.

- *humilis* mont. cap. *Pino* simili C. B. phyt. 531. 13.

*Facea pumila* *Narbonensis* Park. 471. fig. 6.

*Facea* mont. capite magno *Stroboli* l. B. 3. l. 25. p. 30. fig.

*Chabr.* 343. Ic. 3.

*Stœbe Pinea* amplo capite Barrel. 970. Ic. opt. 138.

Some of the bottom *Leaves* of this are whole, which are not exprest in any *Figure* yet extant. I have received very fair *Specimens* of this elegant Plant from that *Accurate Botanist* Dr. *John Salvadore* at *Barcelona*. It *Grows* plentifully about *Narbonne* and *Montpelier*, where it *Flowers* in *June*, as it did this Summer in *Chelsea* Garden.

20. *Cobweb-headed Yellow Portugal Knapweed* Ray Vol, 3.  
p. 204. 28.

*Carduus Lusitan. canescens*, alato caule, capite lanuginoso  
*Fl. Bot.* 350. *Inst.* 441.

*Jacea Lust.* canescens alato caule, capite spinoso & lanuginoso Ray Vol 3. p. 204. pl. 28.

Its Root-Leaves like *Scabious*, but on the Stalk whole and narrow, its Head woolly like a *Cobweb*, beset with long Thorns in the midst of which comes a yellow Flower. Raised this Summer in *Chelsea* Garden.

21. Succory leaved, *Yellow Oriental Knap-weed*.

*Jacea lutea Oriental.* capite spinis simplicibus armato.

The lower Leaves are lobated like the *Stæbe* Salam. 1. Clus. but on the Stalks they are plain and narrow. At the Top grow specious yellow Flowers like the *Sultan*, of that Colour, set in scaly Heads, each ending in a single longish Prickle.

I have as yet seen this only with Mr. Fairchild at *Hoxton*, raised from Seed which Dr. Sherard sent to Mr. Stonestreet.

22. Purple *Knapweed* with black edged Scales. Ray 322. 21.

*Jacea carnea*, marginibus squamarum nigris Nobis.

*Jacea humilis, Hieracii folio* Park 471. 5. H. Lugd. 1193. fig.

*Jacea humilis alba, Hieracii folio* C. B. 271. 2. phyt. 530.

12.

*Jacea pumila* Ad. 235. fig. pumila serpens acaulis ferme

*Lob. Ic.* 542. 2.

*Jacea Monspeliaca* cui in squamis fibræ nigræ, interdum acaulis I. B. 2. l. 25. p. 29. Chabr. 343. Ic. 1.

*Lobel* first observed this at *Montpelier*, where it is more commonly found with a white Flower than a purple. Mr. Jexreel Jones gathered it about *Lisbon*, a very fair Specimen of which *Monsieur Vaillant* sent me from *Paris*.

23. Austrian and Spanish *Stæbe* Ray. 324. 4.

*Stæbe Gallica & Austriaca* elatior Clus. l. 4. p. 10.

*Stæbe*

*Stæbe Austriaca* elatior *Park.* 476.

*Stæbe* major calyculis non splendentibus *C. B.* 273. 3.

*Stæbe Salmantica* alterius, altera species *Clus.* *Hisp.* 362

*Centaureum* majus in *Muris Gesn.* *Hort.* 252.

- - species tenuifolia *Chabr.* 345. *lc.* 6. *l. B.* 3. *l.* 25. p. 31. fig.

*Jacea* alba *Lugd.* 1192. *lc.* 2.

*Jacea Stæbe* dicta 4. *C. B. phyt.* 532. 19.

*Jacea* non spinosa, fol. magis divisis elatior, capitulis minoribus non splendentibus *Bob. Oxon* 140. 15.

Its lower Leaves small and deeply cut, its Flowers purple like the *Common*, with small half starr'd hairy Scales

*Monf. Riqueur* sent me the Seed of this from *Madrid*, which Flowred in *Chelsea Garden* this *Autumn*.

24. *Pona's* Pine-leaved Candy Knapweed.

*Chamæpeuce* *Pr. Alpin Exot.* 76. fig. ex sententia *G. Sherard.*

*Chamæpitys* *Berthiolo.*

*Chamæpitys* fruticosa *Cretica* *Belli.*

*Jacea* fruticans *Pini* folio *C. B.* 271. 3. *Pluk.* *Tab.* 94 fig 3.

*Jacea Cretica* frutescens, *Elychrisi* folio, fl. magno purpurascente *T. Coral.* 32.

*Stæbe Rorismarini* folio *Jonst.* 731. fig. 4.

*Stæbe* capitata *Rorismarini* folio *Pona* 329. fig. *Chabr.* 344.

*lc.* 4. *l. B.* 3. *l.* 25. p. 36. fig.

*Stæbe* capit. overo *Chamæpino* fruticoso di *Candia* *Ponæ Ital.* 75. fig.

*Stæbe Cretica* fruticans, *Piceæ* aut potius *Pini* angustis foliis crebrius stipatis *Bob. Oxon.* 137. 8. *Ray* 3. p. 204. 29.

This is not the *Cyanus* arborescens longifolia *Pr. Alp. Exot.* p. 30. as *Parkinson* and some others assert.

*Dr. Plukenet's* Figure (which he took from *Sir George Wheeler's* Specimen) very well agrees with the Pattern which *Dr. Sherard* sent me from *Smyrna* A. D. 1705. *Prosper Alpinus's* also is well cut. *Pona's* amongst those of  
Mount



*Mount Baldus* was taken from a Garden Plant, but that in the *Italian Edition* from a Native.

This elegant Plant I have only seen with Mr. *Fairchild* at *Hoxton*, raised from the Seed which Dr. *Sherard* sent to the Reverend Mr. *Stonestreet*.

25. Ash-leaved *Scabious* Ray Vol. 3. p. 236. pl. 30.  
*Scabiosa Fraxinella* folio *Institut. Rei Herbar.* 666.

This is a specious Plant and grows in *Chelsea Garden* near two Foot high, its lower *Leaves* are much deeper dented than the *Fraxinella*, and more resembles our *Manna Ash*. It *Flowers* in *July* and *August*.

### Umbelliferous Plants, &c.

26. Arch-Angelica Ray 434. 3. *Bob.* H. Oxon. 281. 5.  
*Archangelica* Clus. 114. 1c. *Pan.* 694. *Chabr.* 400. 1c. 6. *Dod.*  
 318. fig. *Jonst.* 1000. fig. 3. *Park.* 940. fig. 4. I. B. 3. l.  
 27. p. 143. fig.

*Angelica Casalp.* 307. c. 48.

*Angelica* sylv. montana C. B. 156. 5. *phyt.* 273. 4. *Moriss.*  
*Umb.* 9. pl. 3.

*Angelica* mont. maxima, flosculis candicantibus, ad caulium nodos umbellifera *Pluk.* Tab. 134. fig. opt. 1. *Alm.*  
*Bot.* 30.

*Imperatoria Archangelica* dicta *El. Bot.* 267. *Inst.* 317.

Grows on the *Alps* and other Mountains.

27. Round Parsley Ray 462. c. 18. 1. H. Ox. B. 293. 13,  
*Aptum peregrinum* foliis subrotundis C. B. 153. 9. *Prodr.*  
 81. fig. *phyt.* 269. 7:

*Daucus* 3. *Diosc.* 2. *Plinii* Col. 109, fig.

*Selinum montanum* *Offic. Dale Suppl.* 103. 2.

*Selinum peregrinum* 1 *Clus.* 199. c. 21. *Hisp.* 431.

*Selinum*

*Selinum* five *Apium* peregrinum 1. *Clus* Park. 929. fig.

*Saxifraga* 3 *Casalp.* 315.

*Visnaga* minor quorundam, *Selinum* peregrinum *Clus.* femine hirsuto I. B. 3. l. 27. p. 94. fig. *Chabr.* 396. Ic. 2.

*Clusius* observed this about *Salamanca* in *Spain*, *Columna* in *Italy*, and Mr. *Ray* in the *Hedges* about *Messina* in *Sicily*.  
28. Geneva *Laserwort.* Ray 427. 5. *Bob. H.* Oxon.

321. 6.

*Laserpitium* fol. latioribus lobatis *Morif.* Umb. 29.

- - - majus *Almagest.* Botan. 207.

*Libanotis* latifolia altera C. B. *Phyt.* 277. 3.

- - - five *vulgatior* C. B. pin. 157. 2.

*Libanotis* *Theophrasti* Lob. Ic. 704. 1. Belg. 857. Obs. 402.

*Libanotis* *Theophr.* major *Jonst.* 1010. Ic. 1.

*Seseli* *Æthiopicum* Herba *Dod.* 313 Fig.

This Grow. plentifully on the Hills about Geneva.

29. Great black *Master-wort* Ray 275. 1.

*Astrantia* *Clus.* 194. fig. major *Morif.* Umbell. 7. &

- maj. coronâ flori purpurascente *Instit. Rei Herbar.* 314.

*Astrantia nigra* Ger. 828 Ic. *Jonst.* 978. fig. Lob. Ic. 681. 2.

Belg. 829. Obs. 388.

*Astrantia nigra* major *Bob. H.* Oxon. 279. 1.

*Helleborus* niger *Sanicula* folio major C. B. 186. 5. *phys.*

340. 4.

*Imperatoria* nigra *Tab. Hist.* 300. fig. 1. *Sanicula* scem. Ic. 831.

- *Ranunculoides* *Sanicula* folio major *Alm.* Botan. 198.

*Sanicula* fœmina *Fuchsi* 670. fig

- - quibusdam aliis *Elleborus niger* I. B. 3. l. 34. p. 638 fig.

*Veratrum* nigrum *Diosc.* *Dod.* 38. fig.

I have seen the Tops of this mixt with some vulnerary Herbs from Germany.

It Grows on the Alps and the Hills about Geneva.

30. Shrub *Hartwort.* Ray 476. c. 5.

*Seseli* *Æthiopicum* *Offic.* Dale suppl. 101. 45. Lob. Ic. 634. 1.

Ad. 284. Belg. 771 fig.

*Seseli*

*Seseli Æthiopicum* frutex *Bob.* H. Ox. 298. c. 27. *Dod.* 312: fig. *Ger.* 1233. *lc.* *Fonst.* 1421. *lc.* *Park.* 907. fig. 14.

*Seseli Æthiopicum* fruticosum, folio *Perichlymeni* *Chabr.* 406. *lc.* 4. *I. B.* 3. l. 27. p. 197. fig.

*Seseli Æthiopicum* *Salicis* folio *C. B.* 161. 7.

- - *Herbariorum* *C. B. phyt.* 286. fig.

*Bupleurum* arborecens *Salicis* folio *E. B.* 260. *Inst.* 310.

This Grows on the Sea-Coast at *Marseilles* and about *Montpeller*.

31. Great Turnsole Ray 501.

*Heliotropium* *Dod.* 70. fig.

*Heliotropium* majus *Diosc.* *C. B.* 253. 1. *phyt.* 487. 1.

*Heliotropium* majus *G.* 264. *lc.* 1. *Fonst.* 334. *lc.* 1. *Park.* 438. f. 1.

*Heliotropium* majus fl. albo *I. B.* 3. l. 33. p. 60. fig.

*Heliotropium*, *Herba Cancræ* *Chabr.* 521. *lc.* 1.

*Heliotropium* majus & *Herba Cancræ* *Lob.* *lc.* 260. 2. *Belg.* 313. *Obs.* 132. *lc.*

Grows wild in many Places of *France*, *Italy*, *Germany*, &c.

32. Galen's Horehound Ray. 557. 9.

*Alyssum* *Galenæ* *Clus.* 35. fig. *Hisp.* 387. *Dod.* 88. *Park.* 590. f. 4.

*Alyssum* *Galenæ* *Ger.* 379. fig. *Fonst.* 465. *lc.* 1.

*Alyssum* *Galenæ* *Clusii* & *Herbariorum* *Lob.* *lc.* 524. 1. *Belg.* 620. *Obs.* 283.

*Alyssum* verticillatum, foliis profundè incisfis *C. B.* 232.

*Marrubium* album, fol. profundius incisfis, fl. cæruleo *Bob.*

*Ox.* 377. 12. *Seçt.* xi. *Tab.* x. fig.

*Marrubium* *Hisp.* lupinum, calyce stellato & aculeato *E. B.* 61. *Inst.* 192.

*Dr. Salvadore* hath sent me this from *Barcelona*: It grows also about *Madrid* and other parts of *Spain*.

33. Galen's Horehound with more deep cut Leaves.

*Alyssum* *Galenæ* foliis altius incisfis *Nobis*.

Like the Common, but the Leaves much deeper cut, and stand

stand on longer footstalks. Both these I have observed in *Chelsea Garden*.

34. *Spanish Silver Horehound*.

*Marrubium Hisp. supinum*, fol. sericeis argenteis E. B. 161. *Inst.* 192.

*Marrubium album Hispan. majus Barrel.* 263. Ic. 686.

This was raised in *Chelsea Garden* from Seed which Monsieur *Ricqueur* sent me from *Madrid*, and the Plant is very well exprest in *Barrelier's Icons*.

35. *Anguillara's Horehound* Ray 3. p. 303. 11. & 304. 8. *Pseudo-Dictamnus Hisp Scrophularie folio*. E.B 157. *Inst.* 188. *Galeopsis Anguillara* 278. sive *Pseudo-Dictamnium nigrum Siculum* Boc. *Musf.* 151. Tab. 114.

Dr. *Laurence Heister* Professor of Anatomy at *Altorf* sent me formerly a Specimen of this, amongst divers curious Plants he had gathered in the *Physick-Gardens* at *Amsterdam* and *Leyden*.

Dr. *Herman's Figure* very accurately agrees with this Plant.

*Marrubium album rotundifolium Hispanicum maximum Schol. Bot.* 60. *Parad. Batav.* 201. fig. opt.

36. *Herman's Cupt Hore-hound* Ray 3. p. 303. 10. *Marrubium Dictamni spurii foliis & facie Parad. Bat.* 200. fig.

*Pseudo-Dictamnus Hisp. folio rugosiore Schol. Bot.* 61. *Bob. Oxon.* 380. 4.

*Pseudodictamnus Hisp. fol. crispis & rugosis* E. B. 157. *Inst.* 188.

*Pseudo-Dictamnus nigro rotundo crispo folio Boc. Musf.* 152. Tab. 1.

This chiefly differs from the Common in having thinner and larger Flower-cups; its *Leaves* more pointed and somewhat dented.

37. *Common Cupt Horehound* Ray 557. XI.

*Pseudo-Dictamnus* Park. 28. fig. 2.

*Pseudo-Dictamnus verticillatus inodorus* C. B. 222. 2. *phyt.* 424 2.

Qq

*Pseu-*

*Pseudodictamnus* fol. non crenatis, verticillatus inodorus.  
Bob. H. Ox. 379. 1.

*Pseudodictamnus* Cam. Epit. 474 fig. opt Dod. 281. fig.  
Ger. 651. f. 2. *Fonst.* 795. f. 1.

*Pseudodictamnus* floribus verticillatis Lob. 502. Ic. 2. Belg.  
592. Obs. 267. fig.

This is known from the last, in having smaller *Cupps*,  
plain and rounder *Leaves* on very woolly *Stalks*.

38. Broad *Phlome*, Yellow or French Sage, Ray 511. 13.  
*Phlomis* fruticosa, *Salvia* folio latiore & rotundiore *Inst.*

177.

*Salvia* frut. lutea, latifolia, *sive* *Verbascum* sylv. &c. Park.  
52. fig xi.

*Verbascum* latis *Salviæ* foliis C. B. 240. 1. phyt.  
455. 1.

*Verbascum* sylv. Matth. Clus. 28. fig. 1.

*Verbascum* 4 Matth. Lob. Ic. 56. B. 661. Obs. 302.

The French call this Plant, *Sauge Sauvage* or *Wild Sage*.

It Grows plentifully on *Sierra morena* or the black mountain  
supposed the *Mons Marianus* of the Antients, situate be-  
tween *Portugal* and *Andalusia*, where the Natives call this  
Plant *Matulera*. My worthy Friend Mr. Charles du Bois  
tells me the Country People about *Mitcham* use this as a  
certain Remedy in the *Quinsy*.

39. Narrow *Phlome*.

*Phlomis* fruticosa, *Salvia* folio longiore & angustiore *Inst.*

177.

The *Leaves* of this are very like *Common Sage*, but  
paler above and whiter underneath, and much lesser than  
the last and narrower. That accurate Botanist Dr. *Salva-*  
*dore* hath sent me this from *Barcelona*.

40. Aleppo *Phlome*.

*Pseudo-Salvia Chalepensis* ampliore folio cordiformi *Bobart*.

H. Ox. 397. 2. *Seet.* xi. Tab. 16. fig.

These

These *Leaves* differ from the *Broad Phlome* in being thicker, more rugged and cordated at the Footstalk : I am obliged to Mr. *Jacob Bobart* for the first Knowledge of this Plant, which I have since observed with Mr. *Thomas Fairchild* at *Hoxton*.

41. *Samos Phlome*.

*Phlomis Samia Lunaria* folio, Boer p. 62.

*Phlomis Samia Herbacea*, folio *Lunaria* T. Coral. 10.

The *Flowers* pale, buff or whitish, the inside or lower Lip pounct or shaded with brown, the Bottoms of each Calyx are guarded with two or three long slender Thorns: its Root or lower Leaves, in Shape, resemble *Garden Honesty*, but are stiffer, and underneath soft and whitish.

I have as yet observed this Plant only in *Chelsea Garden* where it *Floured* in *July*.

42. True Old Time Ray 519. 3. c. 7. *Lecan* 43. p. 80.

*Thymus Capitatus* qui *Dioscoridis* C.B. 219. 3. phyt. 414. 3.

*Thymum legitimum* Clus. 357. fig. opt.

*Thymum legitimum capitatum* Park. 7. fig. 1.

*Thymum Creticum* Jonst. 574. fig. 3. opt.

*Thymum Cret.* f. *Antiquorum* I. B. 3. l. 28. p. 262.

This fragrant *Time* of the *Antients* I first received from *Coes*; it grows also about *Sevill* and *Cales*.

43. Broad Candy Savory, Ray 519. 4.

*Satureia Cretica* C. B. 218. 4. phyt. 413. 4. Jonst. 576. f. 4.

*Satureia Cretica* Jonst. 576. f. 4. latiore folio Bob. H. Ox.

412. 6.

*Thymbra legitima* Clus. 358. fig. 1. opt.

*Thymbra legitima Dioscoridis* Ponæ 104.

*Thymbra* f. *Satureia Cretica legitima* Park. 5. fig. 4.

*Thymum Creticum* Ponæ verticillatum Barrel. 278. Ic. 898.

*Tragoriganum Clusii* Ger. 543. fig.

It's distinguish'd by its broad *Time* leaves and close Whorles.

44. Black rough Goat Succory Ray 523. 3. *Lecan.* 37. p. 77.

*Tragoriganum* P. *Alp.* 78. fig. c. 36. Dod.

*Tragoriganum Creticum* C. B. 223. 4. *Park.* 17. fig. 1.

*Tragoriganum Cretense* *Jonst.* 668. Ic. 3.

*Tragoriganum* 2 altera species *Clus.* 355. fig. 3.

*Alpinus* and *Clusius* his *Figures*, which are both *Originals*, very well agree with this Plant, which *Jacob Bobart* not long since sent me a Sample of, and has much narrower and smaller Leaves than the broad Candy Savory.

45. Narrow-leaved Goat-Savory Ray 523. 1. *Lecan.*  
36. p. 76.

*Tragoriganum* *Ger.* 543. fig. 1.

*Tragoriganum* *Clus.* *Jonst.* 668. fig. 2.

*Tragoriganum alterum* *Clus.* 355. fig. 2. *Hisp.* 240. fig. Dod. 286.

*Tragoriganum angustifolium* C. B. 223. 3.

-- 2. C. B. *phyt.* 422. x. fl. albo *Clus.* *Lob. Obs.* 264. fig. Ic.  
494. 1.

*Tragoriganum Hispanicum* *Park.* 17. f. 3.

*Tragoriganum tenuioribus folijs fl. candido* *Chabr.* 421.

Ic. 4. I. B. 3. l. 28. p. 261. fig.

*Sideritis Hispanica erecta fol. angustiore* E. B. 160. *Inst.*  
191.

*Monf. Ricqueur* sent me the Seed of this elegant Plant from *Madrid*, which *Flowered* with us in *Chelsea* Garden.

46. Sage Iron-wort, Ray 566. 17.

*Sideritis marina Salvifolia nostra* *Donati* 84.

*Sideritis Heraclea Dioscoridis*, five *marina Salvifolia nostra*  
*Donato* *Park.* 1681. fig. 16.

*Betonica maritima*, flore. ex luteo pallescente *Inst.* 203.

*Dr. Magnol* found this on the Stoney Sea Shores in *Languedoc*: and *Dr. Salvadore* hath sent it me from *Barcelona*. It much resembles the *Sideritis glabra arvensis* *Chabr.* 473. Ic. 1. but has yellowish *Flowers* and softer *Leaves*. It *flowers* with us in *June* and *July*.

### III.

N. B. The *Rest* will be incerted in the next *Transactions*.

---

III. *Observations of the late Total Eclipse of the Sun on the 22d of April last past, made before the Royal Society at their House in Crane-Court in Fleet-street, London. By Dr. Edmund Halley, Reg. Soc. Secr. With an Account of what has been communicated from abroad concerning the same.*

**T**Hough it be certain from the Principles of Astronomy, that there happens necessarily a Central Eclipse of the Sun in some part or other of the Terraqueous Globe, about Twenty Eight times in each Period of Eighteen Years; and that of these no less than Eight do pass over the Parallel of *London*, Three of which Eight are Total with continuance: yet, from the great Variety of the Elements whereof the *Calculus* of Eclipses consists, it has so happened that since the 20th of *March, Anno Christi 1140*, I cannot find that there has been such a thing as a Total Eclipse of the Sun seen at *London*, though in the mean time the Shade of the Moon has often past over other Parts of *Great Britain*.

The Novelty of the thing being likely to excite a general Curiosity, and having found, by comparing what had been formerly observed of Solar Eclipses, that the whole Shadow would fall upon *England*, I thought it a very proper Opportunity to get the Dimensions of the Shade ascertained by Observation; and accordingly I caused a small Map of *England*, describing the Track and Bounds thereof, to be dispersed all over the Kingdom, with a Request to the Curious to observe what they could



could about it, but more especially to note the Time of Continuance of total Darkneſs, as requiring no other Inſtrument than a *Pendulum Clock* with which moſt Perſons are furniſh'd, and as being determinable with the utmoſt Exaſtneſs, by reaſon of the momentaneous Occultation and Emerſion of the luminous Edge of the Sun, whoſe leaſt part makes Day. Nor has this Advertiſement failed of the deſired Effect, for the Heavens having proved generally favourable, we have received from ſo many Places ſo good Accounts, that they fully answer all our Expectations, and are ſufficient to eſtabliſh ſeveral of the Elements of the *Calculus* of Eclipses, ſo as for the future we may more ſecurely rely on our Predictions; though it muſt be granted, that in this our Astronomy has loſt no Credit.

The Day of the Eclipse approaching, I received the Orders of the Society to provide for the Obſervation to be made at their Houſe in *Crane-Court*, and accordingly I procured a *Quadrant* of near 30 Inches *Radius*, exceedingly well fixt with Telescope Sights, and moved with Screws ſo as to follow the Sun with great Nicety; as alſo a very good *Pendulum Clock* well adjusted to the mean Time, and ſeveral Telescopes to accomodate the more Obſervers.

In order to examine both Clock and Quadrant, I, on the 20th of April, obſerved the Diſtance of the upper Limb of the Sun from the Zenith  $36^{\circ}.16'$ , and the next Day  $35^{\circ}.58'$ ; by which it appeared that the Diſtances from the *Zenith* taken by this Quadrant ought to be encreaſed by about one Minute: and that Allowance being made, by ſeveral Obſervations taken before and after Noon on the ſaid 21ſt Day. the Clock was found to answer the apparent Time or Hour of the Sun with ſufficient Exaſtneſs, as not going above 10" too faſt. The next Day April 22<sup>o</sup>, juſt before the Eclipse began, we took three Diſtances of the Sun from the Zenith, viz. at  $7^h.42'.52''$ . A. M. the  
correct

correct Distance of the Sun's Center à *vertice* was  $62^{\circ}.1'.40''$ . At  $7^h.45'.48''$ . it was  $61^{\circ}.34'.40''$ . And again at  $7^h.48'.55''$  it was  $61^{\circ}.6'.40''$ : which with the given Declination of the Sun and Latitude of the Place shew the true Times respectively to have been  $7^h.42'.38''$ ,  $7^h.45'.35''$ . and  $7^h.48'.39''$ : all concurring that the Clock was only 14 Seconds too fast, and had gained scarce any thing sensible in a Day's time: so that it might be entirely depended upon during the Continuance of the Eclipse.

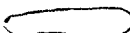
Having computed that the Eclipse would begin at  $8^h.7'$ , I attended soon after Eight with a very good Telescope of about Six Foot, without stirring my Eye from that part of the Sun whereat the Eclipse was to begin: and at  $8^h.6'.20''$ . by the Clock, I began to perceive a small Depression made in the Sun's Western Limb, which immediately became more conspicuous; so that I concluded the just Beginning not to have been above five Seconds sooner; that is, exactly at  $8^h.6'00''$  correct Time.

From this time the Eclipse advanced, and by Nine of the Clock was about Ten Digits, when the Face and Colour of the Sky began to change from perfect serene azure blew, to a more dusky livid Colour having an eye of Purple intermixt, and grew darker and darker till the total Immersion of the Sun, which hapened at  $9^h.9'.17''$ . by the Clock, or  $9^h.9'.3''$ . true time. This Moment was determinable with great nicety, the Sun's light being extinguish'd at once; and yet more so was that of the Emerfion, for the Sun came out in an Instant with so much Lustre that it surprized the Beholders, and in a Moment restored the Day, *viz.* at  $9^h.12'.26''$ . true time, after he had been totally obscured for  $3', 23''$  of Time. And as near as I could estimate the Points on the Moon's Limb; where the last Particle of the Sun vanished was about the middle of the *South East* Quadrant of her Limb, or about 45 Degrees from her *Nadir* to the Left-Hand: And the first  
Emerfi-

Emerſion was about Ten Degrees below the Horizontal Line through the Moon's Center on the Weſt ſide ; and at 14 Minutes paſt Nine, correct Time, I judged the Horns of the Eclipse to have been exactly perpendicular, and by conſequence, the Centers of the Sun and Moon to be in equal Altitude.

It was univerſally remarked, that when the laſt part of the Sun remained on his Eaſt ſide, it grew very faint, and was eaſily ſupportable to the naked Eye, even through the Teleſcope, for above a Minute of Time before the total Darkneſs; whereas on the contrary, my Eye could not endure the Splendour of the emerging Beams in the Teleſcope from the firſt Moment. To this perhaps two Cauſes concurred ; the one, that the Pupil of the Eye did neceſſarily dilate it ſelf during the Darkneſs, which before had been much contracted by looking on the Sun. The other, that the Eaſtern parts of the Moon, having been heated with a Day near as long as Thirty of ours, could not fail of having that part of its Atmosphere replete with Vapours, raiſed by the ſo long continued action of the Sun ; and by conſequence it was more denſe near the Moons Surface, and more capable of obſtructing the Luſtre of the Sun's Beams. Whereas at the ſame time the Weſtern Edge of the Moon had ſuffered as long a Night, during which there might fall in Dews all the Vapours that were raiſed in the preceeding long Day ; and for that reaſon, that part of its Atmosphere might be ſeen much more pure and transparent. But from whatever cauſe it proceeded, the thing it ſelf was very manifeſt and noted by every one.

About two Minutes before the Total Immerſion, the remaining part of the Sun was reduced to a very fine Horn, whoſe Extremities ſeemed to loſe their Acutenefs, and to become round like Stars. And for the Space of about a Quarter of a Minute, a ſmall Piece of the Southern Horn  
of

of the Eclipse seemed to be cut off from the rest by a good interval, and appeared like an oblong Star rounded at both Ends, in this Form : which Appearance could proceed from no other Cause but the Inequalities of the Moon's Surface, there being some elevated parts thereof near the Moon's Southern Pole, by whose Interposition part of that exceedingly fine Filament of Light was intercepted.

A few Seconds before the Sun was all hid, there discovered it self round the Moon a luminous Ring, about a Digit or perhaps a tenth Part of the Moons Diameter in Breadth. It was of a pale whiteness or rather Pearl colour, seeming to me a little tinged with the Colours of the *Iris*, and to be concentrick with the Moon, whence I concluded it the Moon's Atmosphere. But the great height thereof far exceeding that of our Earth's Atmosphere; and the Observations of some, who found the Breadth of the Ring to encrease on the West Side of the Moon, as the Emerfion approached; together with the contrary Sentiments of those whose Judgment I shall always revere, makes me less confident, especially in a Matter whereto, I must confess, I gave not all the Attention requisite.

Whatever it was, this Ring appeared much brighter and whiter near the Body of the Moon than at a Distance from it; and its outward Circumference, which was ill defined, seemed terminated only by the extream Rarity of the Matter it was composed of; and in all Respects resembled the Appearance of an enlightned Atmosphere viewed from far: but whether it belonged to the Sun or Moon I shall not at present undertake to decide.

During the whole time of the Total Eclipse I kept my Telescope constantly fixt on the Moon, in order to observe what might occur in this uncommon Appearance: and I found that there were perpetual Flashes or Coruscations of Light, which seemed for a Moment to dart out

from behind the Moon, now here, now there; on all Sides; but more especially on the Western Side a little before the Emerfion : And about two or three Seconds before it, on the fame Western Side where the Sun was juft coming out, a long and very narrow Streak of a dusky but ftrong Red Light feemed to colour the dark Edge of the Moon; tho' nothing like it had been feen immediately after the Immerfion. But this instantly vanifhed upon the firft Appearance of the Sun, as did alfo the aforefaid luminous Ring.

As to the Degree of Darknefs, it was fuch that one might have expected to have feen many more Stars than I find were feen at *London* : The three Planets, *Jupiter*, *Mercury* and *Venus* were all that were feen by the Gentlemen of the Society from the Top of their Houfe, where they had a free Horizon : and I do not hear that any one in Town faw more than *Capella* and *Aldebaran* of the Fixed Stars. Nor was the Light of the Ring round the Moon capable of effacing the Luftre of the Stars, for it was vailtly inferiour to that of the full Moon, and fo weak that I did not obferve that it caft a Shade. But the under Parts of the Hemisphere, efppecially in the *South Eaft*, under the Sun, had a crepufcular brightnefs : and all round us, fo much of the Segment of our Atmosphere as was above the Horizon and was without the Cone of the Moon's Shadow, was more or lefs enlightened by the Sun's Beams : and its Reflection gave a diffufed Light which made the Air feem hazy, and hindred the Appearance of the Stars. And that this was the real Caufe thereof, appears by the Darknefs being more perfect in thofe Places near which the Center of the Shade paft, where many more Stars were feen, and in fome not lefs than Twenty ; though the Light of the Ring was to all alike.

During the Time whilft the Sun recovered his Light, feveral Altitudes were taken to examine the Regularity of the  
the

the Clock's Motion ; and though the Sun now rose much slower than at the beginning, yet they all conspired within a very few Seconds that the Clock went still one Quarter of a Minute too fast. And the End of the Eclipse approaching, I attended the Moment thereof with all the Care I could, and concluded the compleat Separation of the Sun and Moon at  $10^h. 20'. 15''$ . by the Clock, or exactly  $10^h. 20'$ . correct time.

Hitherto I exhibit only what my self saw, but there were with us a great many of the Members of the Society ; and the Right Honourable the *Earl of Abingdon* and the Lord Chief Justice *Parker* were of the Number : the latter of which shewed an uncommon Curiosity and Desire of Exactness, his Lordship doing us the Honour to assist at most of the Observations made for determining the Error of the Clock ; and did himself, at the Moment of the Emergence from total Darkness, observe the Distance of the Planet *Jupiter* from the Zenith  $48^\circ. 29'$ . by which the Time thereof is verified.

There were also present several foreign Gentlemen, and among them *Monfieur le Chevalier de Louville* and *Mr. Monmort*, both of them Members of the *Royal Academy of Sciences at Paris* : the first whereof came purposely to observe this Eclipse with us, and having seen the Beginning applyed himself to take Digits with his Micrometer, and to observe the Occultations of three Spots at that time seen in the Sun ; and he was pleased to communicate the following Notes, *viz.*

	h.	'	"	
At 8	28	20		Four Digits were Eclipsed.
8	32	57		The First and bigger Spot touched the Moon.
8	33	18		The same was wholly hid.
8	34	08		The first of the two lesser Spots was hid.
8	34	58		The Second of them was hid.

- h. ; °  
 At 9. 36. 01 Emerſion of the greater Spot.  
 9. 38. 26 Emerſion of the firſt leſſer Spot.  
 9. 40. 25 Emerſion of the ſecond leſſer Spot.  
 10. 20. 04 The End of the Eclipse.

And he determined the time of the total Darkneſs 3'. 22'', or one Second leſs than by my Account.

The Heavens were all the while very propitious to us, and there was very little or no Wind, and not ſo much as one Cloud interrupted our View from the Beginning to the End; but no ſooner was the Eclipse over, but a great Body of Clouds hid the Sun for many Hours after.

Theſe Obſervations having been made with all the Care we could, are not, 'tis hoped, far from the Truth.

What we have received from other Places is as follows,

The Reverend Mr. *James Pound* Rector of *Wanſted* in *Effex* and R. S. S. gives the following Account of the principal Phænomena obſerved there; he being furniſh'd with very curious Inſtruments, and well ſkill'd in the Matter of Obſervation, and having rectified his Clock by ſeveral Altitudes of the Sun taken both before and after, *viz.*

- h  
 At 8. 6. 37 The Eclipse firſt perceived.  
 9. 9. 28 The Total Immerſion.  
 9. 12. 48 The Emerſion.  
 10. 20. 32 The juſt End of the Eclipse.  
 6. 3. 20 The Continuance of total Darkneſs.

The near Agreement of this Obſervation with our own (the Difference being only what is due to the Difference of our Meridians) makes us the leſs ſolicitous for what was noted at the *Royal Obſervatory* at *Greenwich*, from whence we can only learn that the Duration of Total Darkneſs was 3'. 11''.

The

The Reverend Mr. *William Derham* Rector of *Upminster* in *Essex* and *Reg. Soc. Sod.* assisted by *Samuel Molyneux* Esq; Secretary to his *Royal Highness* the Prince, and other Persons of Quality, made the following Observations there, which he has lately communicated, *viz,*

- h.  
 At 8. 7. 41 The Eclipse began.  
 8. 33. 46 The Moon touched the greater Spot.  
 8. 34. 36 She touched the middle Spot.  
 8. 35. 41 She touched the third Spot.  
 9. 10. 58 The total Darkeness began on a sudden, and *Aldebaran* appeared,  
 9. 14. 6 The Emerfion or End of total Darkeness.  
 9. 3. 8 Continuance of total Darkeness.  
 9. 42. 41 The third and laft Spot discovered.  
 10. 21. 45 The End of the Eclipse, by a  $13\frac{1}{2}$  Foot Glaſs.

And a little before the Beginning of the Eclipse, he found the greater and preceeding Spot to be more Northerly than the Sun's Center  $373\frac{1}{2}$  ſuch Parts as the Sun's Diameter was 1647, and that it followed his Western Limb 0'. 43" of Time: by which *data* the Situation of that Spot is well determined.

Our Profeſſors of Astronomy in both Universities were not ſo fortunate: My worthy Colleague Dr. *John Keill* by reaſon of Clouds ſaw nothing diſtinctly at *Oxford* but the End, which he obſerved at 10h. 15'. 10". As to the total Darkeneſs, he could only eſtimate it by the ſudden Change of the Light of the Sky; and reckoned its Continuance but 3'. 30"; which was certainly too little, the Center of the Shadow having without doubt paſt very near *Oxford*. And the Reverend Mr. *Roger Cotes* at *Cambridge* had the miſfortune to be oppreſſed by too much Company, ſo that, though the Heavens were very favourable, yet he miſſ'd both the time of the Beginning of the Eclipse and that of  
 total



total Darknefs. But he observed the Occultations of the three Spots, viz, of the first and greateft at  $8^h. 34'. 11''$ . of the fecond at  $8^h. 35'. 15''$ , and of the laft at  $8^h. 36'. 55''$ . He noted alfo the End of total Darknefs at  $9^h. 14'. 37''$ , and the exact End of the Eclipse at  $10^h. 21'. 57''$ .

We have received feveral Accounts from fome Places which lay near the Track of the Center of the Shade, and which might have been very proper to determine the greateft Continuance of the Darknefs; as from *Plymouth, Exeter, Weymouth, Daventry, Northampton* and *Lynn regis*, all agreeing that the whole Sun was obfcured at thofe Places full four Minutes, and at fome of them rather more. But thefe Observers give us no Account how they meafured this Time, and therefore it may well be fupposed they took it in a round Number, and perhaps from pocket Minute-Watches. What I think may beft be relied on for this Purpofe, are two correfponding Observations made, the one at *Barton* near *Kettering* in *Northamptonshire*, where by the Observation of *John Bridges* Efq; Treafurer of his Majesty's Revenue of Excife, and R. S. S. with a good Pendulum-Clock and all due Care, the whole Sun was hid no more than  $3'. 53''$ . The other was by Mr. *John Whitefide*, A. M. Keeper of the *Afhmolean Museum* at *Oxford*, and a fkilful Mathematician, who obferved after the fame manner, at *King's-Walden* in *Hertfordshire* near *Hitchin*, that the total Eclipse continued but  $3'. 52''$ . Hence it follows that the Center of the Shade paff near the middle between thefe two Places, which are but 30 Geographical Miles afunder, and fitate near at right Angles to the Way of the Shade, and therefore that the total Obfcurity, where longeft, could laft but about  $3'. 57''$ , or perhaps a fecond or two more at *Lynn* and lefs at *Plymouth*: the Velocity of the Progreff of the Shade gradually decreasing, and its Diameter encreafing as it paff on to the Eaftwards. And this Situation of the middle Line is confirmed by an Observa-  
tion

tion made at the Seat of the Right Honourable the Lord *Foley* at *Witley* eight Miles beyond *Worcester*, by his Order, and communicated by his Lordship to the Royal Society; whereby it appears that the total Darkness lasted there 3'. 15". Hence it follows that *Witley* was about three or 4 Miles farther from the Center of the Shade on the North-side than *London* on the South; and *Witley* being by *Ogilby's* Mensurations, 118 measured Miles from *London*, it is plain that the Center past over *Islip*, which is, by the same Ad-measurement, 57 such Miles on that Road, and about five Miles almost due North from *Oxford*; so that the Center of the Shade left *Oxford* but very little upon the right Hand. This Situation agrees perfectly well with the former between *Barton* and *King's Walden*, and as far as the Geography of our Country may be relied on, I conclude the Center to have entred upon *England* about *Plymouth*, and to have past over *Exeter*, the *Devizes*, *Islip*, *Buckingham* and *Huntington*, leaving *Oxford* and *Bedford* on the Right, and *Lynn* on the Left, and to have quitted the Coast of *Norfolk* about *Wells* and *Blakeney*.

As for the Limits of the Shade, both on the North and South side, we have by Enquiry gotten them with all the Exactness the thing is capable of, and we should have been glad the *French Astronomers* had done the like for the Total Eclipse that past over *Languedoc*, *Provence* and *Dauphiny* on the First of *May* 1706. But as this is the first Eclipse of this kind that has been observed with the Attention the Dignity of the Phænomenon requires, we hope those which may happen for the future to traverse *Europe*, may not pass by so little regarded as hitherto.

As to the Southern Limit or Term where the Eclipse ceased to be Total on the South side of the Sun. we have received an Account of an Observation made at *Norton-court* about Ten Miles on this side *Canterbury*, by the Reverend Dr. *John Harris*, S. T. P. Prebendary of *Rocheſter* and

and R. S. S. assisted by that accurate Observer Mr. *Stephen Gray*; by which we learn that the Eclipse began there at 8<sup>h</sup>. 8'. 55". and ended at 10<sup>h</sup>. 24'. 47"; and that the Total Darkness continued but about one Minute or rather less, the middle thereof being at 9<sup>h</sup>. 13'. 52". From this Duration it will follow that *Norton-court* was but about 3 or 4 Miles within the Shade. And that it was really so is confirmed by the Relation of the Inhabitants of *Boſton*, about Midway between *Norton-court* and *Canterbury*, who assured Mr. *Gray*, as he was returning home that same Day, that the Eclipse was not Total there, but, as one of them exprest it, before the Sun had quite lost his Light on the East-side he recovered it on the West: and that there was a small Light left on the lower part of the Sun that appeared like a Star. And from *Cranbrook* in *Kent*, we are informed, by the Relation of the curious *William Tempest* Esq; R. S. S. that he observed there the Sun to be extinguished but for a Moment, and instantly to emerge again: So that the Limit past exactly over this Town, which is about 38 Geographical Miles from *London*, and very near the right Angle where the Perpendicular from *London* falls on the Line of the Limit, being 3'. 00 of Time to the Eastwards of *London* in the Latitude of 51°. 6', as near as I can gather.

How it past over *Suffex* we have not so authentick Relations, but have learnt that it was Total at *Wadhurst* beyond *Tunbridge-wells*, as also for some short time at *Lewis*; but that it was not so at *Brightling*, which Place being situated on an Eminence that has a commanding Prospect, all the Country to the Northward was seen in Darkness, whilst they there had some Benefit of a small Remainder of the Sun.

From these Observations we may conclude that this Limit came upon the Coast of *England*, about the middle between *Newhaven* and *Brightelmston* in *Suffex*, and passing by

by *Cranbrook* and *Boſton*, left *Canterbury* about 4 Miles on the Right hand, and quitted the Coaſt of *Kent*, not far from *Hern* toward the antient *Regulbium*, now called *Reculver*. So that it ſeems ſcarce one third part of *Kent*, and not ſo much of *Suffex*, out of all the South Coaſt of *Great-Britain*, eſcaped being involved in this Darkneſs.

The Northern Limit, having paſt over a much greater Space, has had more Obſervers, and is not leſs curiouſly determined than the other. We find by the Account given by the Reverend Mr. *Roger Proſſer*, Rector of *Haverford-Weſt*, that the Eclipse was total there a Minute and half, whence it follows that *Haverford* was but about 6 Miles within the Limit; and therefore that it entred on *Pembrokeshire* about the middle of *St. Brides Bay*, leaving *St. David's* and *Cardigan* on the left Hand: and having traversed thoſe two Counties and *Montgomery-shire*, it entred on *Shropshire*, leaving the Town of *Shrewsbury* 1'. 40". in the Shadow, as was obſerved there by Dr. *Hollings*: whereby it appears that *Shrewsbury* was about 8 Miles within the Limit. Thence it proceeded by the Eaſt ſide of *Cheshire*, leaving *Whitchurch* and *Nantwich* a very little without; and paſſing by *Congleton* went over the Peak of *Darbyshire* into *Yorkshire*, and croſt the great Northern Road between *Pontefract* and *Doncaſter*, ſomewhat nearer the former than the latter. For by the Obſervations of that curious Gentleman *Theophilus Shelton* Eſq; at *Darrington* about two Miles on this ſide *Pontefract*, (in Lat. 53°. 40' and Long. Weſt from London 4'. 40". of time, as may be concluded from *Norwood's* Meaſure of a Degree) the Sun at 9<sup>h</sup>. 11'. was reduced almoſt to a Point, which both in Colour and Size reſembled the Planet *Mars*; but whiſt he watched for the Total Eclipse, that Point grew bigger and the Darkneſs diminiſhed; whence he argued the Limit to have been very little more Southerly. And ſince he has been informed that it was juſt Total in *Barnſdale*, three Miles South from thence.

And that it was so at *Badsworth* about the same Distance from *Darrington*, we are told by a Letter of the Reverend and Learned Mr. *Daubuz*, that he has a certain Account from that Place, that the luminous Ring round the Moon was seen there, which was no where visible but while the Eclipse was Total. From these *Data* we may securely determine the Remainder of this Track, and that the Edge of the Shadow having past over the rest of *Torkshire* went off to Sea about *Flamborough* head.

So that of the forty Counties into which *England* is subdivided, only the five most Northerly have not had the Sun wholly hid from them ; and six others have escaped but in part, viz. *Shropshire*, *Cheshire* and *Torkshire*, and the extream part of *Darbyshire* on the *North*, and *Kent* and *Sussex* on the *South* ; all the rest of the Kingdom having more or less suffered an Interval of Total Darkness.

I shall not at present consider this Eclipse as universal, but only as it related to *England* ; and it shall suffice to say, that the Shadow came out of the *Atlantick* Ocean, having past over the Islands *Azores* ; and that the Southern Limit thereof reach'd the Isle of *Ushant*, and the Northwest Coasts of *Britanny* between *Brest* and *Morlaix* ; and dividing our Islands of *Guernsey* and *Jersey*, just touch'd upon the Promontory of *Normandy* called *Cape de Hague*. And that after it had quitted *England* and traversed the *German Ocean*, it fell on *Jutland* on the Southside, and *Norway* on the *North* ; and thence proceeded to the Eastwards over *Sweden*, *Finland*, &c.

It remains now to consider the Figure, Position, Direction, Velocity and Magnitude of the Shadow at is past over us. And first as to the Figure, 'tis obvious that the Shadow of the Moon being a Cone and the Earth's Surface sufficiently Spherical, the apparent Shadow on the Earth will be the common Intersection of a Cone and Sphere, which is a Figure hitherto little considered by Geometers ;  
and

and not being *in Plano* is not to be exactly described but in the Spherical or Conical Surface. How to find the Points of this Curve in all Cases is taught by *P. Courfier*, in a very scarce Latin Book printed at *Dijon* in *Burgundy*, and published at *Paris* in the Year 1663 : nor do I hear of any other Author that has handled the same Subject since, though capable and worthy of further Improvement. By what he there delivers, *Prop. 11. 12. Lib. I.* it will be easily understood, that the Convexity of so small a part of the Earths Surface as the Shadow commonly occupies, can produce but an inconsiderable Effect ; so that without sensible Errour we may take it for a Plain, and the Section for a true *Apollonian Ellipsis*, whose transverse *Axis*, by reason of the smallness of the Angle of the Cone, will be to its Conjugate nearly as *Radius* to the *Sine* of the Sun's Altitude at its Center, especially if he be considerably elevated. But when he is near the Horizon, it will be necessary to have regard to the true Figure, by reason of the great Length to which the Transverse Axe is extended, and particularly when the Shade is entring upon or leaving the Earth's Disk. Of these perhaps a fuller Account may be given upon a further occasion.

As to the Position of the *Axis* of the Shadow, it is manifest that it must always lie in the Plane of a great Circle of the Earth passing through the *Axis* of the Cone of the Shade : and therefore it will be only requisite to obtain the Azimuth and Altitude of the Sun at the Place where the Center of the Shade at any time is found, to determine the Situation of the Axe and *Species* of the Ellipse required. Thus the middle of the Eclipse at *London* having been observed at  $9^h. 10'. 45''$ , by the given Latitude and Declination we find his Azimuth about  $59^\circ. 00'$ . and Altitude  $40^\circ. 46'$ . that is just 40 Degrees high at the Center of the Shadow. Wherefore the Transverse Axe of the Ellipse was to its Conjugate very near as *Rad.* to the *Sine* of  $40^\circ$ ,

or as 1000 to 64; *proximè*; and did make an Angle of  $59^{\circ}$ , or very little more, with the Meridian passing at that time through the Center of the Shade.

Next the Direction and the Velocity of the Motion wherewith the Center of the Shade past over *England* comes to be considered, wherein the Reader is to be told that the Shadow passes in a very compound Curve, which, as the former, is not *in plano*, and only describable on the Surface of the Sphere: nor is its Motion equable, but compounded of very many Elements producing a great Variety. By what Method its Points, and its Tangents in those Points, are to be obtained, I reserve to the next Opportunity, this Account being designed for the Curious in general: only I must acquaint them, that for so small a part of the Curve as went over *England*, it may be esteemed a right Line, with more Exactness than we usually find in most of our Geographical Charts. And the like may be said for the Velocity, which, though in our present Instance it was continually decreasing, may, for so short a time, be supposed to have been the same without sensible Errour.

By a careful Calculation I have determined the Velocity of the Motion, at the Time of the Middle of the Eclipse at *London*, to have been 29 Geographical Miles in a Minute of Time *quam proximè*: and that its Way made an Angle of  $52^{\circ}.45'$  with the Meridian towards the Eastwards of the North; wherefore the said Way made an Angle with the Axis of the Ellipsis of  $68^{\circ}.15'$ . And the greatest Duration of Total Darkeness having been  $3'.57''$ , (as was before shewn) it will follow, that that Diameter of the Elliptick Figure according to which the Shade past, was no less than  $114\frac{1}{2}$  Geogr. Miles. And from the Elements of the Conicks 'tis easy to be proved, that supposing the Figure of the Shade a true Ellipse, whose Axes are as *Radius* to the *sine* of 40 Degrees, the greater Axis would be 171 Geographical Miles, and the lesser 110; and the nearest distance between the Limits supposed Parallel 164 such Miles.

And

And this Length of the *Axis* of the Shade, derived purely from the Continuance of Total Darkneſs, is fully confirmed by the obſerved Diſtance of the Parallel Limits; the one paſſing by *Badſworth* in *Yorkſhire*, the other by *Cranbrook* in *Kent*. For by the two Latitudes  $53^{\circ} 37'$  and  $51^{\circ} 6'$ , with the Difference of Longitude  $7'$  and  $40''$  of Time, or  $1^{\circ} 55'$ , the Diſtance of theſe two Places is given  $166\frac{1}{2}$  Geogr. Miles; with the mean Angle of Poſition 25 Degrees from the North Weſtwards; wherefore this Arch makes an Angle with the Track of the Shade of  $77^{\circ}\frac{1}{4}$ : and hence the neareſt Diſtance of the Parallels becomes 16; ſuch Miles, which by the other Way was found 164.

If therefore we conclude the *Axis* of the Shadow, when the Sun was juſt 40 Degrees high, to have extended over  $2^{\circ} 50'$  of a great Circle, we may ſecurely determine the Difference of the Sun and Moon's Diameters at this time. For the Difference of the Horizontal Parallaxes of the Sun and Moon being found to be  $60'. 38''$ . (as ſhall be hereafter ſhewn, but is not required with extream exactneſs for this Purpoſe) the Difference of the Parallaxes in Altitude at both Ends of the *Axis*, will be found to be  $1'. 56''$ ; and by ſo much did the Diameter of the Moon when forty Degrees high exceed that of the Sun: Hence the Horizontal Diameter of the Moon in this Anomaly is found  $33'. 27''$ , which may ſerve for a Rule in all other Caſes.

I forbear to mention the *Chill* and *Damp* which attended the Darkneſs of this Eclipse, of which moſt Spectators were ſenſible, and equally Judges. Nor ſhall I trouble you with the Concern that appear'd in all Sorts of Animals, *Birds*, *Beaſts* and *Fiſhes* upon the Exinction of the Sun, ſince our ſelves could not behold it without ſome ſenſe of Horror.

Laſtly, I have added the following *Synopſis* of ſuch Obſervations as have hitherto come to my Hands; acknowledging the Favour of all thoſe, who have been willing to promote our Endeavours to perfect the Doctrine of Eclipſes.



Place	Observer	Beginn. h. . "	Immerf. h. , ,	Emerf. h. . , ,	Tot.	End. h. . "
<i>Barton</i>	<i>M. Bridges</i>				3.53	
<i>Bell-bar</i>	<i>M. Jones</i>	8. 6.25	9. 9.45	9.13.27	3.42	
<i>Broadway</i>			8.47.00	8.49.30	2.30	
<i>Carmarth.</i>						
<i>Cambridge</i>	<i>M. Cotes</i>			9.14.37		10.21.57
<i>Canterbury</i>	<i>M. Gray</i>	8.10.00				10.24.30
<i>Chester</i>	<i>M. Ward</i>	7.57.40				10. 6.35
<i>Crew</i>	<i>M. Wright.</i>		9. 2. 8		2.00	10. 9.00
<i>Dublin</i>	<i>L. Arch Bish.</i>	7.42.11				9.49.40
<i>Dublin</i>	<i>M. Hawkins</i>	7.41.30				9.48.45
<i>Exon</i>	<i>L. Bishop</i>		8.55. 0	8.59. 0	4.00	10. 0.00
<i>Exon</i>	<i>M. Hudson</i>	7.47.30			3.30	10. 0.30
<i>Greenwich</i>	<i>M. Flamsteed</i>				3.11	
<i>King's Wald.</i>	<i>M. Whitfide</i>				3.52	
<i>Llanidan</i>	<i>M. Rowland</i>	7.52.30				
<i>Anglesey</i>						
<i>London</i>	<i>R. Society</i>	8. 6 00	9. 9. 3	9.12.26	3.23	10.20.00
<i>Northampt.</i>	<i>M. Hawkins</i>		9. 5.22	9. 9.24	4. 2	10.15.35
<i>Norton-court</i>	<i>D. Harris</i>	8. 8.55	9.13.23	9.14.22	0.59	10.24.47
<i>Oxon</i>	<i>D. Keill</i>				3.30	10.15.10
<i>Paris</i>	<i>R. Academy</i>	8.11.00				10.28.00
<i>Plymouth</i>	<i>M. Heines</i>	7.41.00	8.45.30	8.50.00	4.30	9.54.30
<i>Portchester</i>	<i>C. Candler</i>		9. 2.25	9. 6.15	3.50	
<i>Salop</i>	<i>D. Hollings</i>	7.58. 0			1.40	10. 6.00
<i>Upminster</i>	<i>M. Derham</i>	8. 7.41	9.10.58	9.14. 63	3. 8	10.21.45
<i>Wansted</i>	<i>M. Pound</i>	8. 6.37	9. 9.28	9.12.48	3.20	10.20.32
<i>Weymouth</i>	<i>M. Hobbs</i>		8.54.00	8.58.00	4.00	
<i>Witley</i>	<i>M. Baxter</i>	7.59. 0			3.15	10.13.00

IV. *An Account of a Book. Bibliographia Anatomica Specimen. sive Catalogus omnium pene Auctorum, qui ab HIPPOCRATE ad HARVEIUM Rem Anatomicam ex professo vel obiter scriptis illustrarunt, &c. Curâ & Studio JACOBI DOUGLAS, M. D. Reg. Soc. S. & in Colleg. Chirurg. Londinensi Prælect. Anatom. 8vo. Londini 1715.*

**T**HE Author of this Treatise, whose admirable Skill in the Practice of Dissections, as well as in the Theory of the Structure of the Parts, leaves him not many Equals, in order to discover what Improvements and Progress Anatomy has met with, and with what Industry the Study of it has been cultivated, has with much Application perused a very great Number of Authors who have advanced the Science ; observing therein who have the Honour of being the first Discoverers, and who have unjustly arrogated to themselves that Title, that each may receive a due Proportion of Praise according to his Merit. And in this Decision he has impartially weighed their Deserts, the better to lay before the Reader the Increase of these Studies, and to determine more exactly the Differences that have arisen about who are first Inventors ; which the Book, Chapter and Page where they are treated of will easily manifest.

The History, Lives and Elogies ascrib'd to Anatomists, which he has inserted either from their own Writings, or their Editors, or Commentators, will afford a great Variety of Pleasure, in which he has been particularly care-

ful to set down the Names, Sur-Names, Country, Time of their Birth, what Year they died in, under what Masters educated, where they flourish'd, and in what part of Anatomy they excell'd.

Nor has he been less diligent in the Account he has given of the Books of *Anatomy*, which his Friends supply'd him with in great Number. The Reader will see here laid before him, all the several Editions, in what Language, what Volume they were printed in, with the Place and date of the Year they were published at; and which are the first Impressions, and which copied from them. Nor has he judg'd it improper to give some Account of the Figures dispers'd up and down in Anatomical Books; as whether they were Originals or Copies, cut in Wood or Copper, &c. To these he has added three Indexes, whose Use will be seen by the Titles. As for the difference of Style remarkable in this Treatise, It is chiefly owing to the Variety of Authors made use of, he thinking himself not at Liberty to vary the Expression of them whose Authority he quotes.

He says he would willingly have recounted the great Advantage Anatomy has received from the *English* Nation: but out of just Regard to their Merits, he has resign'd this Province to his Friend Mr. *William Becket*, whose Industry in collecting their Writings will not in his Opinion exceed his Talent and Abilities to recommend them to the World.

He hopes the Reader will pardon him in this, that as several Books and Editions came late to his Hands, he was forc'd to add the *omissa* separately: which being in greater Number than at first expected, the Author earnestly desires the Favour of those who have in their Collections any thing of this kind here omitted, that they would please to communicate the same, in order to render this first *Specimen* still more complete.

# PHILOSOPHICAL TRANSACTIONS.

For the Months of *June, July and August, 1715.*

## The CONTENTS.

- I. *Experimenta Barometrica pro varia diversæ Aeris Elasticitate exploranda, in variis Helvetiæ locis, &c. à Johanne Jacobo Scheuchzero, M. D. Math. P. Tigurino & R. S. S.*
  - II. *Botanicum Hortense IV. Giving an Account of divers Rare Plants, Observed the last Summer A. D. 1714. in several Curious Gardens about London, &c. By James Petiver, F. R. S.*
  - III. *OBSERVATIONES COELESTES BRITANNICÆ, Grenovici in Observatorio Regio habitæ, anno MDCCXIII.*
  - IV. *An Account of an Experiment made by Dr. Brook Taylor assisted by Mr. Hawkesbee, in order to discover the Law of the Magnetical Attraction.*
  - V. *A short Account of the Cause of the Saltness of the the Ocean, and of the several Lakes that emit no Rivers; with a Proposal, by help thereof, to discover the Age of the World: Produced before the Royal Society by Edmund Halley, R. S. Secr.*
- Accounts of BOOKS.*
- I. *Linear Perspective, or a New Method of representing justly all manner of Objects, &c. By Brook Taylor, L. L. D. and R. S. Secr.*
  - II. *DUCATUS LEODIENSIS, Or, The Topography of the ancient Town and Parish of LEEDS and Parts adjacent, in the County of YORK, &c. By Ralph Thoresby, Esq; Fellow of the Royal-Society, London.*

I. *Experimenta Barometrica pro varia diversi Aeris Elasticitate exploranda, in variis Helvetiæ locis, occasione Excursionis Alpinae, mense Sept. Anni præteriti susceptæ. Ope Tubi 32 digit. Parisin. longi, 2 linn. diametro. à Johanne Jacobo Scheuchzero, M. D. Math. P. Tigurino. & R. S. S.*

Columna prima notat Aerem in Tubo relictum. Secunda altitudinem Mercurii supra Argenti vivi superficiem; Tertia spatia Aeris expansi. Quarta notat descensum Mercurii propter Aerem relictum.

D. 6. Septembr. *Tiguri*, Barometri totius altitudo hor. 8. ant. erat 26 digit. *Parisiens.* 4 linn. H.  $9\frac{1}{2}$  vero 26 digg.  $4\frac{1}{2}$  linn.

Col. I. digg.	Col. II. digg. lin.		Col. III. digg. lin.		Col. IV. digg. lin.	
3	19	9 bis	12	$6\frac{1}{2}$ bis	6	$7\frac{1}{2}$
6	16	8	15	$7\frac{1}{2}$	9	$8\frac{1}{2}$
	16	$7\frac{1}{2}$	15	8	9	9
9						
12	11	11 bis	20	3 bis	14	$5\frac{1}{2}$
15	9	9 bis	22	6 bis	16	$7\frac{1}{2}$
18	7	$5\frac{1}{2}$ 2	24	$8\frac{1}{2}$ 4	18	11
	7	6 5	24	8 4	18	$10\frac{1}{2}$
21	5	3	27	0 bis	21	$1\frac{1}{2}$
24	3	3	28	11 bis	23	$1\frac{1}{2}$
27	1	6	30	$7\frac{1}{2}$ bis	24	$10\frac{1}{2}$
30	0	4	31	$10\frac{1}{2}$ bis	26	0

D. 11. Sept. in Pascuo *Alpino Ennense* gen Aberen  
 Montis Liberi, *Glaronensis* ditionis, h. 1. pom. cœlo fe-  
 reno Altitudo totius Barometri 23. 10 bis.

Col. I.	Col. II.		Col. III.		Col. IV.	
digg.	digg.	lin.	digg.	lin.	digg.	lin.
3	18	7	13	6	5	3
6	15	$7\frac{1}{2}$	16	4	8	$2\frac{1}{2}$
9	13	3	18	7	10	7
12	11	$1\frac{1}{2}$	20	9	12	$8\frac{1}{2}$
15	9	0	22	9	14	10
18	6	11	25	0	16	11
21	4	11	26	10	18	11
24	3	0	28	10	20	10
27	1	4	30	5	22	6
30	0	2	31	8	23	8

D. 12. Sept. h. 7. ant. cœlo fereno, auf ~~Scherf~~ jugo editi-  
 ore Montis Liberi. Altitudo totius Barometri 21. 8.

3	17	6	14	6	4	2
6	14	7	17	3	7	1
9	12	6	19	6	9	2
12	10	5	21	6	11	3
15	8	5	23	6	13	3
18	6	5	25	3	15	3
21	4	7	27	1	17	1
24	2	$9\frac{1}{2}$	29	$0\frac{1}{2}$	18	$10\frac{1}{2}$
27	1	4	30	6	20	4
30	0	2	31	8	21	6

D. 12. Sept. h 9. ant. cœlo fereno, auf dem ~~Blattenflock~~  
 jugo editiore Montis Liberi. Altitudo tot. Barom. 21. 6.

3	17	$2\frac{1}{2}$	14	6	4	$3\frac{1}{2}$
6	14	5	17	5	7	1
9	12	4	19	6	9	2
12	10	$4\frac{1}{2}$	21	5	11	$1\frac{1}{2}$

Col. I.	Col. II.		Col. III.		Col. IV.	
digg.	digg.	lin.	digg.	lin.	digg.	lin.
15	8	7	23	4 $\frac{1}{2}$	12	11
18	6	7	25	3	14	11
21	4	8	27	3	16	10
24	2	9	29	0	18	9
27	1	3	30	5	20	3
30	0	3	31	6	21	3

D.14. Sept. h.12. intra ipsam Venam Chalybis *Sarunetanam*, 300. incirca passus ab ostio, cœlo foris sereno. Barometri totius altitudo 24. 4. & 24. 3.

3	18	9	13	1	5	7
6	15	9	16	1	8	7
9	13	5	18	5	10	11
12	11	3	20	7	13	1
15	9	1	22	9	15	3
18	7	0	24	10	17	4
21	4	11	27	0	19	5
24	3	0	28	10	21	4
27	1	4	30	6	23	0
30	0	3	31	6	24	1

Extra hanc Venam metallicam sub dio eandem altitudinem observavi Mercurii in Barometro integro, item in 3 & 9 digg. Aeris in tubo relictæ Sed notandum est aerem in intimis fodinæ partibus, ubi experimenta feci, fuisse ob ignem præterito die accensum (quo venam durissimam coquunt fossores) rarefactum, & locum hypocausti instar moderatè calefactum.

N. B. *Multis experimentis coram R. Societate factis comperitum est, Aeris compressi vires Elasticas, esse ut pondera comprimantur directè. His Cl. Scheuchzeri observatis patet eandem in Aere rarificato obtinere regulam quam proxime; Nam licet differentia aliqua reperitur, tanta non est, ut ab inæqualitate diametri Tubi non facile oriatur. Ut autem experimenta hæc rite fiant, oportebit Tubi capacitatem, immisso unciatim Mercurio, in æquales partes dividi, loco partium longitudine æqualium.*

Bo-

---

BOTANICUM Hortense IV.

*Giving an Account of divers Rare Plants, Observed the last Summer A. D. 1714. in several Curious Gardens about London and particularly the Society of Apothecaries Physick-Garden at Chelsea.*

By James Petiver, F. R. S.

---

*Continued from the last Transactions.*

---

47 *Planta Nasifloræ. Snout-Flowers.*

**A** Lehoof Snapdragon. Ray Hist. Plantar. p. 567. pl. 3.

*Cymbalaria Hederae terrestris folio, flore maximo. Antirrhino seu Linariae affinis fol. Hederae terrestris. Flor. Batav.*

*Asarina Lob. Lugd. 915 fig. 2.*

*Asarina Lob. flore Hederae terrestris l. B. 3. App. 840. fig.*

*Asarina sterilis, Sevena Narbonensis agri Lob. Obs. 329 lc.*

*Asarina five saxatilis Hederula Lob. Icon. 601.*

*Hedera saxatilis Jonst. 856. fig. 2.*

*Hedera terrestris, magno flore C. B. 306. Phyt. 609. 3.*

Its Flowers, Seeds and Capsules plainly shew it to be a kind of Snapdragon. Lobel says this grows wild in Narbone and Provence (from whence I should be glad to see it,) but his Figure does not express the Hoariness with which our Leaves are endowed, nor are its Flowers so large or Exact. I first saw this elegant Plant in the

X x

Amster-



*Amsterdam Physick-Garden, Flowering in July, and since at Chelsea.*

48. English Yellow Pansy. Ray's *British Herbal* Tab. 37. fig. 10.

*Viola montana lutea grandiflora nostras* Ray 1052. 5. *Syn.* ed. 215. 8.

*Viola* 5. *Jonst.* 853. *Ger* 704.

Mr. Ray observed this in divers boggy mountainous Pastures in *Darbyshire, Yorkshire, and Wales.* It Flowers very well in our Gardens, and makes a beautiful edging.

49. Bog Violet. Ray's *British Herbal* Tab. 37. Fig. 5.

*Viola palustris rotundifolia* Plot. *Hist. Oxon.* 144. 4. Tab. 9. fig 2. Ray 1050. 4. *Synopf.* 152. 4. edit. 2. p. 214. 4.

*Viola palustris rotundifolia glabra* Moris. *Oxon.* 475. 5. sect. 5. Tab. 35. fig.

Dr. Plot first discovered this in the Bogs about *Stonwood* in *Oxfordshire*, and *Chiswell* in *Barkshire*, since which it hath been found in the like Places between *Wickam* and *Croydon* in *Surry* plentifully, from whence it was transplanted into *Chelsea Garden.* It Flowers in *April* and *May.*

50. Hairy Wood Violet. Ray's *British Herbal* Tab. 37. fig. 7.

*Viola Trachelii folio* Morret. pin. 125.

*Viola Martia hirsuta, major, inodora* Plot. *Oxon* 144. 3.

Ray 1051. 5. *Synopf.* 152. 6. ed. 2. p. 215. 6.

*Viola Martia major, hirsuta inodora* Moris. *Ox.* 475. 4. S. 5 Tab. 35. fig.

Grows plentifully in *Charlton* and other Woods in *Kent,* &c. It Flowers in *March* and *April.*

51. Upright Tree-Violet Ray 1052. 1.

*Viola arborescens vel potius erecta* Camer. *Epit.* 511. fig. opt.

*Viola assurgens tricolor* *Ger.* 703. *lc.* 2. *Jonst.* 854. fig.

*Viola elatior* *Clus.* 309.

*Viola Martia arborescens purpurea* C. B. 195. 2.

*Viola Martia surrectis cauliculis* *Lob.* *lc.* 610. 2.

*Jacea tricolor*, surrectis caulibus, quibusdam arborea dicta  
Chabr. 510. Ic. 3. I. B. 3. l. 32. p. 547. fig.

*Clusius* observed this to grow common in the Woods of  
*Austria* and *Styria*. Dr. *Morison* in his *Hist. Oxon.* p.  
476. says this is found in *England* on the Tops of *Moun-*  
*tains* and in *Woods*, which has not as yet been observed,  
either by the inquisitive Mr. *Ray* or any other.

*Plantæ Bacciferae.* Berry-bearing Plants.

52. Long Horse-tongue Ray 663. 1.

*Bonifacia* five *Bislingua* Chabr. 45. Ic. 5. & 6. I. B. 1. l. 5.  
p. 575. fig.

*Hippoglossum Camer.* Epit. 919. fig.

*Hippoglossum Dioscoridis* & *Lauroraxa Plinii* Col. 165.  
fig. opt.

*Hippoglossum* five *Bislingua* Barrel. pl. 5. Ic. 249. Park.  
702. Ic.

*Hippoglossum* mas & feminæ Ger. 761. Ic. 1. & 2. Jonst. 908.  
Ic. 1. & 2.

*Radix Idea*, *Hippoglossum* Col. phyt. 64. fig.

*Ruscus angustifolius*, fructu folio innascente *El. Bot.* 70.  
*Inst.* 79.

This and the next are accurately *Figured* by *Columna*  
& *Barrelier*. The peculiarity of this Plant is to have a  
small tongue like the *Key* or *Fruit* of the *Ash-tree*, growing  
from the middle Rib on the under side of each Leaf.

Grows on shady Mountains in *Italy* and *Hungary*.

53. Round Horse-tongue Ray 663. 2.

*Laurus Alexandrina* *Camer.* Epit 936. Ic. Chabr. 46. Ic. 1. I.  
B. 1. l. 5. p. 574. fig.

*Laurus Alexandrina* & *Chamædaphne* Col. 165. fig. opt.

*Laurus Alexandrina* genuina Park. 700. fig. 1.

*Laurus Alexandrina* vera *Diosc.* & *Theophr.* Barrel. 6. Ic.  
250.

*Laurus alex.* fructu folio infidente C B. 305.

*Ruscus latifolia*, *fructu folio innascente* E. B. 70. *Inst.* 79.

I have a very fair Specimen of this in *Flower*, gathered with the last at *Gibraltar* by Dr. *Pelham Jonston* a curious Botanist.

54. *Cherry Nightshade* Ray 673. 4.

*Amomum Plinii* Ger. 289. fig. *Jonst.* 361. fig.

*Amomum Plinii* *Strycnodendron* five *Solanum arborescens* Lob.

Ic. 265. 1. Belg. 322. *Obs.* 136. fig.

*Pseudo Capsicum* seu *Amomum Plinii* Park. parad. 427. fig. 7.

*Solanum fruticosum* Tabern. 578. Ic. 2.

*Solanum fruticosum bacciferum* CB. 166. 9. *phyt.* 29.

*Solanum fruticosum Americanum* dictum *Amomum Plinii* Park. 353 fig.

Its an old Inhabitant in our Gardens, where it *Flowers* about Midsummer, and its *Cherry-like* Fruit is ripe in the *Winter*.

I have received this from the *Maderas*, where Dr. *Sloan*, that Consummate Botanist, has also observed it.

55. *Virginia Potatoes* Ray 675. 14.

*Batata Virginiana* f. *Virginianorum* & *Pappus* Ger. 781. fig. *Jonst.* 927. fig.

*Arachidna Theophr.* fortè *Papas Peruanorum* Clus. 97. fig.

*Papas* seu *Battatas Virginianorum* Park. parad. 517. fig. 3.

*Papas radix*, ex qua *Edulium Chunno* dictum conficitur *Jos. Acoſta* l. 4 c. 17. imo *Panis* loco utuntur quem

*Chunno* dictum vocant *id.* l. 3. cap. 20.

*Solanum tuberosum* C B. *phyt.* 301. 19.

*Solanum tub. esculentum* C B. 167. 13. *Prodr.* 89. fig. opt.

We are obliged to that indefatigable Botanist *Caspar Bauhine* for a most accurate *Figure* and full *Description* of this useful *Root*, which was first discovered in *Virginia* and there call'd *Openanck*.

It was first cultivated in *Ireland*, and now about *London*, and in many Counties of *Great Britain*. It *Flowers* from *July* till *Autumn* and then *Fruits*, altho' rarely ripens.

Herbæ

*Herbæ capitibus stellatis seu echinatis,*  
*Herbs with Star or Burr heads.*

56. *Avicens Abtilon* Ray 699. 1. H. Oxon. 531.  
*Althea lutea* Ger. 790. fig. *Jonst.* 935. fig.  
*Althea lutea* five *Abutilon Avicenna* putatum *Park.* 304.  
 Ic 5.  
*Althea luteis floribus* *Lob. Ic* 635. 1. *Belg.* 801. *Obs* 374.  
 fig.  
*Althea Theophrasti* fl. luteo *C.B.* 316. 8. *phyt.* 632. 8.  
*Althea Theophrasti* fl. luteo, quibusdam *Abutilon* *I.B.* 2. 1.  
 23. p. 958. fig. *Chabr.* 302. 1c. 1.  
*Caspar Bauhine* observed this Plant, altho' an Annual, 2  
 Cubits high, between *Ferraria* and *Bononia*. Its also a  
 Native of both the *Indies*, from whence I have received it.  
 57. *Betony Mallow* Ray 593. 3 H. Oxon 522. xi.  
*Alcea Betonica* folio fl. purpureo violaceo *Barrel.* 72. 1c.  
 1189.  
*Mal'va Betonica* folio *H. Blef.* 285. *Pocc.* 15. fig *Zan.* 130.  
 fig. 52.  
*Malacoides Betonica* folio *Inst. R. H.* 98.  
 This elegant *Mallow* grows wild in *Tuscany*, from whence  
 it was sent me by *Pet. Antony Micheli* the Grand Duke's  
*Botanist* as also from the Reverend *Bruno Tozzi* Abbot of  
*Vallambrose* and Fellow of the *Royal Society*.  
 58. *Cupain* his Dwarf *Spearwort* Ray 3. p. 361. 27.  
*Ranunculus Alpestris* palustris, lignosus, fol. *Ocimi* echina-  
 tus *H. Cathol.*  
*Ranunculus Siculus* fol. rotundo vix serrato *Gazoph. Natur.*  
 Tab. 24. fig. 9. opt.  
 This is a small stooping Plant, with pretty large Heads,  
 its Leaves broad and lightly notchd. Grows wild in *Sicily*.  
 59. *Muter Cronfoot* Ray 582. 5.  
*Ranunculus magnus* valde hirsutus. fl. luteo *I. B.* 3. 1. 30 p.  
 417. fig. *Chabr.* 465. 1c. 6.

*Ranunculus mont. subhirsutus, Geranii folio* C B. 182. 13.  
*Ranunculus montanus subhirsutus, Geranii folio* C B. pr. 96.  
 6. fig.

*Ranunculus mont latifol. hirsutus alter* C B. *phyt.* 323. 15.

C B. in his *Phytopinax* says he first found this on Mount *Muret* near *Basil*, and afterwards on *Rofsberg* near *Tubing* in *Wirtenbergh*. I received the first Specimen of this from Mr. *Jacob Bobart* at *Oxford*.

### Herbæ *Tetrapetalæ*. Quaterpetals.

60. *Babylonion Cress*, Ray 821. 1.

*Draba prima umbellata* C B. *phyt.* 174. 1.

*Draba vulgaris* Park. 849. fig. 1.

*Draba Dioscoridis* Jonst. 274. fig. 1.

*Draba sive Arabis* Chabr. 295. lc. 6.

*Draba multis fl. albo.* I B. 2. l. 22. p. 939. fig.

*Draba umbellata* vel *Draba maj. capitulis donata* C B. 109. 1.

*Arabis sive Draba & Nasturtium Babylonicum* Lob. lc. 224.

I Belg. 267. fig. Obs. 111.

Grows in the Borders of Fields about *Vienna* plentifully, as also in the like Places in *Italy* and *France*. Flowering in *May* and *June*.

61. *Bur Rocket* Ray 804. 4.

*Erucago segetum* El. Bot. 199. Inst. 152.

*Eruca Monspelica* filiquâ quadrangulâ Park. 821. fig.

*Eruca Monsp.* fil. quadrangulâ echinatâ C B. 99. 14. *phyt.*

149. 15. *prodr.* 41. 7. fig. opt.

*Raphanistrum dispermon Monspel.* fil. quadrangulâ echinatâ H. Leyd. 520.

*Sinapi echinatum* Lugd. 647. fig. Chabr. 275. lc. 3. I. B. 2.

l. 21. p. 858. fig.

Grows about *Montpelier* in *Corn*. It Flowers and Seeds in *June*, &c.

62. *Ever-green Persian Tufts* Ray 837. 7.

*Thlaspi fruticosum Leucoii folio latifol.* C B. 108. 1. *prodr.*

49. 9. Park.

*Thlaspi*

*Thlaspi* frut. umbellatum *Persicum*, fol. *Leucoti* instar sem-  
pervirentibus H. *Oxon* 296. 23.

*Thlaspi* latifol. platycarpon, *Leucoti* foliis *Bocc.* 55. fig.  
opt.

*Thlaspi* sempervirens & florens *Dodart.* 115. fig.

*Thlaspidium* frutic. *Leucoti* folio semperflorens E. B. 183.  
*Inst.* 214.

*Thlaspio* fruticoso di *Persia*, con foglia di *Keiri*, di fiore odo-  
rato *Zanon* 106. Tab. 74. fig.

This is always green, *Flowers* long and especially to-  
wards the *Winter*, its said to come from *Persia*, *Boccone*  
found it wild about *Palermo* in *Sicily*.

63. Garlick *Cress* *Ray* 834. 19.

*Scorodo-thaspi* *Ulixis Aldrovandi* *Chabr.* 294. Ic. 1. I. B. 2. 1.  
22. p. 932. fig.

*Thlaspi* *Allium* redolens H. *Oxon.* 297. 28. Tab. 18. fig.

That very great and laborious Naturalist *Ulixis Aldro-*  
*vandus* first discovered this Plant growing about *Bononia*.  
It *Flowers* and *Seeds* in *Chelsea-Garden* early in the *Spring*.

*Plantæ* H. pentapetalo. *Cinquepetals.*

64. Dwarf *Gentian* with a large Flower *Ray* 718. 2.

*Gentiana* *Alpina* magno flore I B. 3. 1. 31. p. 523. fig.

*Gentiana* *Alp.* pumila, latifol. magno flore *Elem. Botan.*  
96.

*Gentiana* *Alp.* magno fl. cæruleo violaceo *Mariana* *Chabr.*  
503. Ic. 6.

*Gentiana* 5. *Gentianella* major verna *Clus.* 314. fig.

*Gentianella* *Alpina* verna major *Park.* 402. fig. 1.

*Gentianella* *Alp.* latifol. magno flore C B. 187. 1. phyt. 347.  
16 *prodr.* 97. c. x. 1:

*Gentianella* *Helvetica* *Lob. Icon.* 310. 1. Belg. 381.

*Gentianella* *Campanula* flore purp. *Helvetia* *Adv.* 130. fig.

I B. makes this and the *Angustifolia* to be the same  
Plant.

Grows

Grows on most Mountains in Austria, Styria and Switzerland, where it Flowers in their Spring, viz. in June, or as soon as the Snow there melts.

This elegant Plant is pretty common in most of our Country Gardens.

65. Pona's blew *Valerian* Ray 745. 6.

*Cervicaria Valerianoides cærulea* C B. 95. 20.

*Rapunculus Valerianoides cæruleus umbellatus* Boer. 104. 3.

*Rapuntium umbellatum* Col. phyt. 2. p. 22.

*Trachelio azuro umbellifero* Pona Ital. 44. fig.

*Trachelium umbelliferum cæruleum* Park. 645. 8.

*Valerianoides Alpin. Trachelii folio, fl. coccineis* Alm. Bot.

379.

This is very different from the *Telephium* fl. purpureis Lobel. Ic. 389. 2. as *Columna* and C B. from him take to be the same.

Pona, in his Italian Edition of the Plants on Mount Baldus, gives the first Figure and Description of this elegant Plant, which he received from Signior Contareni at Venice, and supposes it to come from Candy; but Pere Barrelier says it grows in moist shady Places not only about Rome but Valentia in Spain; where its also sometimes found with a white Flower. Its blew umbelliferous Tufts make a beautiful Shew in our Physick Garden where it Flowers from Midsummer till the end of September.

66. Childing Pink Ray 990. 13. H. Ox. 563. 21.

*Caryophyllus sylv. prolifer* C B. 209. 6. phyt. 393. 18.

*Caryophyllus prolifera* Park. 1338. fig. 1.

*Betonica Coronaria squamosa* sylv. Chabr. 446. Ic. 6. I B. 3.

l. 29. p. 335. fig.

*Armeria prolifera* Lob. Ic. 449. 1. Belg. 534. Jonst. 599. fig. 5.

Grows in barren Pastures in many Parts of France, Italy, Germany, &c.

67. Gray

67. *Gray Stitchwort* Ray 1020. 7. H. Ox. 546. 44.  
*Holosteum Hart. incanum vulgare Nobis.*  
*Caryophyllus Holosteus* Ger. 277. xi. *Jonst.* 595. fig. 15.  
*Caryophyllus Holosteus tomentosus* I B. 3. l. 29. p. 360. fig.  
*Park.* 1339. fig. 7.  
*Caryophyllus Holost. tomentosus latifolius* CB. 210. 2.  
*pr.* 124. 5.

*Lychnis maritima incana & tomentosa H. Oxon.* 546. 44.  
*Myosotis tomentosa Linaria folio amplo.* E B. 211. *Inst.* 244.

The *Description* of I B. and others much better agree with this Plant than that of C B. *prodr.* p. 104. 5.

There is no good *Figure* of this Herb altho a *Common Edging* in every *Countrey Garden*.

68. Penny's *Myrtle Cistus* Ray 1011. 13.

*Ascyrum Balearicum frutescens, magno flore luteo, fol. minoribus lucidis subtus verrucosis J. Salvadore.*

*Myrto-Cistus Pennei Clus.* 68. fig. *Pan.* 67. fig. *Park.* 665. fig.  
*Ger.* 1098. fig. 16. *Jonst.* 1279. fig. 16. *Tab. Ic.* 1054. 2.

*Myrto-Cestus Pennei, fl. luteis oblongis Chabr.* 103. *Ic.* 2.  
 I B. 2. l. 13. p. 21. fig.

Dr. Penny a famous Physitian of *London* and a very curious Naturalist of that time, first communicated this Plant A. D. 1580. which he had gathered on the Island *Majorca* to *Carolus Clusius*, who gave a *Figure* of it, and from whence all other Authors have since copied it. We are lately obliged to Dr. *John Salvadore* at *Barcelona* for the more perfect Knowledge of it, who amongst many other very curious and Rare Plants gathered in that Island and *Minorca*, sent me this under the Name as above, of which it is a true *Species*.

69. *Matthiolum* his *Coris* or *St. John's-wort* Ray 1018. 4.  
*Coris* C B in *Matth.* 667. fig. *opt. Cam.* 678. fig. *Park.* 570.  
 fig. 1. *Jonst.* 544. fig. 1. *Lob. Ic.* 403. 1. *Belg.* 489. *Obs.*  
 220. fig.

*Coris lutea* C B. 280. 1. *lutea major phyt.* 548. 1.



*Hypericoides Coris quorundam & Coris legitima Cretica*  
Chabr. 456. Ic. 5. l. B. 3. l. 29. p. 384. fig.

*Hypericum seu Coris legitima Erica similis H. Oxon* 469. 4.

*Hypericum Syriacum tenuissimo & glaucō folio El. Bot.*  
222 *Inst.* 255.

*Matthiolus* says this grows in dry Grounds and Hills in many Places of *Italy*, and by *Carara* a Village of *Liguria*, as *Camerarius* asserts.

I take this by its Figure to be different from *Bellus* and *Pona* their *Coris legitima Cretica*:

70. Succory *Mullein*.

*Blattaria Cichorei folio villosō Nobis.*

an *Blattaria Orient. Agrimonia folio. T. Coral.*

Its *Leaves* spread on the Ground, are deeply cut long and hoary, from the midst of these rise slender Stalks, much branched and full of small yellow *Flowers* which soon fall off.

I have as yet seen this in *Chelsea Garden* only.

71. Great *Pile Trefoil* Ray 968. 12. *H. Ox.* 177. 14.

*Lotus Hæmorrhoidalis sive Trifolium Hæmorrhoid. majus*  
*Park.* 1102. fig. 8.

*Lotus pentaphyllos filiquosus villosus CB.* 332. 9.

*Lotus polyceratos frutescens incana alba, filiquis curtis-*  
*crassioribus & brevioribus erectis H. Ox.* 177. 14

*Oxytriphylum alterum Scribonii Herbariorum Lob. Adv.*  
381. fig.

*Trifolium album, rectum hirsutum valde Chabr.* 160. Ic. 1  
l. B. 2. l. 17. p. 360. fig.

*Trifolium Hæmorrhoidale Lob. illustr.* 151.

Grows plentifully about *Montpelier*, *Lobel* says its also found about *Eyons* and *Turin*.

The *Leaves* or rather the *Seed* given in *Powder* from 30 Grains to 60 in *Red Wine*, is said to be very effectual in curing the *Piles*.

72. Lesser *Pile Trefoil* Ray 968 xi.

*Lorus*

*Lotus Haemorrhoidalis* alter minus five *Lotus Lybica* Dal' Park. 1102. f. 9.

*Lotus filiquosus* glaber, flore rotundo C B. 332. 10.

*Lotus Lybica* Dalechampii Lugd. 509. fig.

*Lotus Lybica* Dalech. vulgo H. Leyd. 384.

*Trifolium rectum* *Montepellulanum* I B. 2. l. 17. p. 359. sine fig.

*Trifolium rectum* *Montes.* fl. rotundo C B phyt. 666. 46.

Grows by River sides and moist Places about Messina, Calabria and Montpellier.

73. *Camerarius* his Birds Foot Trefoil. Ray 970. 20.

*Lotus filiquis* *Ornithopodii* C B. 332. 2. phyt. 667. 36. I B.

2. l. 17. p. 359. fig.

*Lotus peculiaris*, filiquis *Ornithopodii* Camer. Hort. 91. Ic. 25. opt.

*Lotus Ornithopodii* filiquis, fl. luteo, nigris lineis striato Chabr. 158. Ic. 1.

*Lotus polyceratos* annuus procumbens latifolius, filiquis *Ornithopodii* H. Ox. 176. 8.

*Lotus sylvestris* *Creticus* Park. 1101. fig. 4. ex Pona Ital. 153.

That Reverend Divine and Botanist Sir George Wheeler, observed this in the Island Corfu.

74. Fine *Fumitory* Ray 406. 3. H. Ox. 261. xi.

*Fumaria tenuifolia* Ger. 928. fig. 3. Jonst. 1088. fig. 3.

*Fumaria minor* five *tenuifolia* Park. 287. fig. 2.

*Fumaria minor* *tenuifolia* C B. 143. 3. phyt. 245. 2.

*Fumaria minor* five *tenuifolia* surrecta Chabr. 277. Ic. 6. I B. 3. l. 26 p. 203. fig.

*Capnos tenuifolia* Clus. 208. fig. 2. Hisp. 375. fig. Lob. Ic. 757. 2. Belg. 914 Obs. 438.

Grows amongst Corn and by Pathways about Montpellier, and in divers parts of Spain where its called *Palomilla*, and flowers in April and May.

75. Barcelona Hart *Fumitory*.

*Fumaria henneaphyllos* *Hispanica* laxatilis Bocc. Mus. 83. Tab. 73.

*Fumaria heneaphyllos Hispan. saxatilis, fl. vario Barret.*  
866. Ic. 42.

*Fumaria Hisp. saxatilis, fol. amplioribus cordiformibus,*  
*sem. compressis El Bât. 334. Inst. 422.*

Dr. *Salvadore* observed this in the Fissures of *Mount Serrat*, and in the Hermits Walls about *Barcelona* where it Flowers in *May, June, and July.*

The curious *Dutchess Dowager of Beaufort* shewed me very fair Specimens of this Plant, which her Grace raised from Seed I had given her.

### Plantæ fructu tricocco. Plants with Treble Husks and Seed.

76. Garden Spurge Ray 866. 18.

*Lathyris* C B. in Matth. 868. fig. 1. Cam. 968. fig. opt.

*Lathyris major* C B. 293. 1. phyt. 577. 1.

*Lathyris major Hortensis* Park. 191. fig. 1.

*Lathyris* five *Cataputia minor* Chabr. 535. Ic. 4. I B. 3. p. 880.  
fig. Jonst. 503. fig. 18.

*Cataputia minor* Lob. Ic. 362. 1. Belg. 439. Obs. 197. Ger.  
405. fig. 14.

*Cataputia minor* five *Lathyris angustifolia* Tab. 587. Ic. 2.

*Tithymalus latifolius Cataputia dictus* H. Leyd.

Grows spontaneously in many Gardens, where it Flowers and Seeds in *July and August.*

77. Red Flowred Spurge Ray 864. 2.

*Characias Monspeliensum* Clus. & Matth. Lob. Ic. 359. 2.

Belg. 43. Obs. 194. fig. 2. Adv. 152.

*Tithymalus Amygdaloides* five *Characias* Chabr. 534. Ic. 2.  
I B. 3. l. 34. p. 672. fig.

*Tithymalus Characias* 1. Clus. 188. fig. 1. Hisp. 436. fig.

*Tithymalus Characias Monspeliensum* Park. 186. 2. Jonst.  
499. fig. 8.

*Tithymalus Characias rubens peregrinus* C B. 290. 2. phyt.  
572. 1.

*Clusius* observed this on the rough Mountains of *Spain*, its also found in *Italy* and about *Montpelier* in stoney Places.

Its dark red *Flowers*, distinguish it from others like it.

78. *Montpelier Meadow Spurge*.

*Tithymalus Lithospermi majoris folio Bot. Monsp. 205.*

An *Tithymalus Tingitanus Linaria folio, lunato flore H. Leyd.*

An *Tithymalus Linariæ folio, lunato flore H. Blef. 313.*

Dr. *Niffole* that curious Botanist sent me this Plant among many others gathered about *Montpelier*.

79. *Soft Spurge of Mount Polline.*

*Tithymalus Montis Pollini, fol. & fructu pubescentibus.*

Its *Stalks* brown and hoary as are its *Leaves* which grow alternately and not thick set. Its *Flowers* and *Seeds* in *July* and *August*.

Monf. *Vaillant* sent me a *Specimen* and *Seed* of this from *Paris*.

80. *Cambridge Corn Spurge Ray 868. 22.*

*Tithymalus Segetum longifolius Cat. Cant. app.*

It grows in the *Corn* beyond *Kingston-wood* in the Road to *Gamlingay* in *Cambridge-shire*, where I found it in company with Mr. *James Sherard*, an accurate Botanist and well vers't in the Knowledge of our *English Plants*:

81. *Cypress Spurge Ray 865. 19. H. Ox. Bob. 335. 4.*

*Tithymalus Cupressinus Jonst. 449 fig. 5. H. Ox. Bob. 335.*

4. 1. Tab. Ic. 594. fig. 2. Hist. 2. p. 293. f. 3. opt.

*Tithymalus Pinea Ger. 402. fig. 6. opt.*

*Tithymalus Cyparissias C.B. 291. 2. T. Esula Chabr. 532. Ic.*

6. 1 B. 3. 1. 34 p. 663. fig. Cam. 964. fig. Lob. Obf. 192.

fig. 3. Adv. 151. C.B. in Matth. 865. fig. 5. Lugd. 1644.

fig. 2. opt.

*Tithymalus Cyparissias minor C.B. phyt. 575. 15,*

*Tithymalus Cyparissias vulg. Park. 193. descr. 3* but its *Figure* is of the *Pyiussa* or *Esula major*.

*Vertues.* Dr. *Tournefort* says the *Root* of this *Spurge* is a proper *Cathartick* in *Hydropick* and *Cachectic Bodies*, as also for *intermittent Feavers* given from ʒss to ʒij with 20

Grains

Grains of *Mercurius dulcis* and 30 of Cream of Tartar, 10, 15 or 20 of its Seed is a strong Purge, and the Basis of *Fernelius* his *Pil. ex Esula*, its Dose ʒij. The Roots of this Plant are also used in the *Benedicta Laxativa*. *Hydragogum eximium Renodei*. Extract. *eximium* & *Cholagogum Rolfinchii*.

It grows pretty common in many Gardens.

82. Common Sea Spurge Ray Brit. Herbal. Tab. 53. fig. 8.

*Tithymalus maritimus* C B 291. 1. phyt. 574. xi.

*Tithymalus Paralius* Chabr. 534. Ic. 6. 1 B. 3. 1 34. p. 674.

fig. Lob. Ic. 354. 2, Belg. 430. Obs. 191. fig. Camer. 962.

fig. opt.

*Tithymalus paralius seu maritimus* Park. 184. fig Ger. 401.

fig. 1. Jonst. 498. fig 1. opt. Matth. Lugd. 1643. fig. 2.

& 47. fig. 1. Tab. 593. Ic. 1. Hist. 2. p. 292. f. 3. C B in

Matth. 864. fig. 3.

This elegant Spurge is found on most of the Sea Coasts of Europe.

83. Small Portland Spurge.

*Tithymalus maritimus minor Portlandicus*.

From a small downright single Root, rise slender Stalks with longish oval Leaves not thick set (as in the common Sea-Spurge) at the Top come small Umbels of Flowers and Seeds like other Spurges. It grows not a Span high even in our Gardens where it is very luxuriant.

The Reverend Mr. William Stonestreet, that accurate Botanist, first discovered this about a Year since on a narrow Neck of Land covered with Peebles which joyns Portland with the Coast of Dorset-shire.

*Arbores Pisifloræ*. Trees with Pea-blooms.

84. Bean Trefoil-tree. Ray 1721. 1.

*Anagyris* Cam. 671. fig. Ger. 1239. fig. 1. Jonst. 1427. fig. 1.

*Anagyris* 1. Tabern. 1089. Ic. 2. Hist. Vol. 2. p. 794. f. 1.

*Anagyris non fætida-major vel Alpina* C B. 391. 3.

*Anagyris live Laburnum majus* Park. 245 fig. 2. opt.

*Anagy-*

*Anagyris minus færens vel Laburnum* Lob. Ic. 2. p. 49. x

• Belg. 2. p. 56. fig:

*Laburnum* Chabr. 78. Ic. 1.

*Laburnum* arbor trifolia *Anagyridi* similis I B. 1. l. xi. p. 361. f.

It *Flowers in May, June, &c.* On *Salève & Jura* two Mountains near *Geneva* where Mr. Ray observed it, as also on the *Alps of Savoy*.

85. Great podded, *Bastard Sena* Ray 923. 1. H Ox. 122. 1.

*Colutea Scorpoides* Lob. Ic. 86. 2. pt. 2. Belg. 100. T. 2.

*Adv.* 405. fig. Chabr. 82. Ic. 1. l. B. 1. l. xi. p. 381. fig.

*Ger.* 1116. fig. 2. *Jonst.* 1299. fig. 2.

*Colutea Scorpoides* 1. *Tab.* 1091. Ic. 1. *Hist.* 695. f. 2.

*Colutea Scorpoides* 1. *elatior* *Clus.* 97. fig.

*Colutea Scorpoides* major *Park.* 227. fig. 2.

*Colutea Scorpoides* *elatior & major frutescens* H. Ox. 122. 1.

*Colutea filiquosa* five *Scorpoides* major C B. 397. 2.

*Emerus* vulgò *Casalp.* 117.

Mr. Ray has observed this about *Montpelier, Geneva, &c.*

86. Common Bladder *Bastard Sena* Ray 1720. 1.

*Colutea* *Ger.* 1116. fig. 1. *Jonst.* 1299. fig. 1. *Tab.* 1090. Ic. 2.

*Colutea* *Theoph.* Lob. Ic. 88. 2. pt. 2. Belg. 101. T. 2. *Obs.* 530.

*Colutea Vesicaria vulgaris* *Park.* 227. fig. 1. C B. 396. 1.

*Colutea Vesicaria* Chabr. 81. Ic. 6. I B. 1. l. xi. p. 380. fig.

*Emeri* alterum genus *Casalp.* 117.

Grows about *Trent* plentifully, as also on *Mount Vesuvius, &c.*

*Arbores Bacciferæ. Berry-trees.*

87. Widdow-wayl Ray 1710. c. 12. *Lecaan* 83. 50.

*Olivella Hispanis.* *Garoupe* *Narbonens.* *Fremb'd* *Seidel* past Germ.

*Chamelea* *Dod.* 633. fig. *Cam.* 573. fig. opt.

*Chamelea tricoccus.* C B. 462. 1. *Clus.* 87. fig. 1 *Hisp.* 170.

fig Chabr. 46 Ic. 3. I B. 1. l. 5. p. 584. fig. *Park.* 202. fig. 5.

*Chamelea Arabum* *tricoccus* *Ger.* 1215. fig. *Jonst.* 1402. fig.

1. *Tab.* 1075. Ic. 2.

*Chamelea vera* aliis *Tricoccus*, *Mezereon* *Cam.* *Hort.* 39.

*Chama-*

*Chamaelea vera*, aliis *Tricoccus* Lob. Ic. 369. 2. Adv. 157.  
fig. Belg. 448. fig.

Grows plentifully in Olive Grounds and on the Rocky Hills about *Montpelier*.

88. Plain Oval *Mock-Privet*.

*Phillyrea folio subrotundo vix ferrato*.

These Leaves much resemble the Figure in *Camerarius* his *Epitome* p. 90. marked thus \* but its notches less visible.

89. True *Mock-Privet*.

*Phillyrea vera*, folio acuto, basi lato.

This also is very lightly notcht.

90. Olive *Mock Privet*. Ray Dendr. 53. 2.

*Phillyrea Olea Ephesiaca* folio Hort. Med. Chelf. Pluk. Tab. 310. fig. 5.

These Leaves are oblong, pointed and wholly plain.

91. Fine dented, small leaved *Mock-Privet*.

*Phillyrea folio minori argutè ferrato*.

The only Tree of this I have as yet seen is in the Wilderness of the Bishop of London's Garden at *Fulham*.

92. Common *Mock-Privet*. Ray 1585. 2.

*Phillyrea fol. Ligustri* C B. 476. 4.

*Phillyrea latiore folio* Ger. 1209. fig. *Jonst.* 1395. fig. 2.

*Phillyrea latiusculo fol.* Chabr. 42. lc. 2. I B. 1. l. 5. p. 539. fig.

*Phillyrea* 3 Clus. 52. fig. 2. *Hisp.* 68. fig.

*Phillyrea angustifolia* 1, Park. 1443 fig. 4. secundum Iconem.

Grows wild in Spain and about *Montpelier*.

93. Common Narrow *Mock-Privet* Ray. 1585. 1.

*Phillyrea angustifolia* Ger. 1209. fig. 1. *Jonst.* 1595. fig. 1.

Chabr. 42. lc. 1. I. B. 1. l. 5. p. 538. fig. Lob. lc. 2. p. 132.

Belg. T. 2. p. 154. fig. *Obs.* 565. fig.

*Phillyrea angustifolia* 1 C B. 476. 5.

*Phillyrea* 4 Clus. 52. fig. 3. *Hisp.* 64. fig.

Frequent about *Montpelier*.

We shall Conclude with the *Indian Herbs and Trees* in the next Transactions.

III. OBSERVATIONES COELESTES  
BRITANNICÆ, Grenovici in Observato-  
rio Regio habitæ, anno MDCCXIII.

Observationes SATURNI.

Temp. per Horolog.	Tempora correcta.	Die Solis, Januarii 25.	Distantiæ a Vertice
h. ' "	h. ' "		° ' "
8 30 15	8 28 5	Geminorum $\pi$ transiit	28 13 20
8 41 7	38 57	Pes Castoris $\eta$ transiit	28 54 50
8 49 8	8 46 58	Calx ejusdem sive $\mu$ transiit	28 50 40
12 10 49	12 8 39	Leonis $\downarrow$ <i>Bayero</i> transiit	36 9 30
12 25 24	23 14	Leonis $\nu$ transiit	37 40 30
12 34 21	32 11	Saturni centrum transiit	36 51 45
12 35 44	12 33 34	Cor Leonis transiit	38 7 00
		Ascensio rect. $h$ 147 55 10	
		Dist. a Polo Bor. 75 23 55	
		Longitudo $\Omega$ 25 8 15	
		Latitudo Bor. 1 31 27	



Temp. per Horolog.	Tempora correcta	Die Jovis Februarii 5. 1713.	Distantiæ a Vertice.
h. ' "	h. ' "		
11 20 52	11 14 10	Leonis $\xi$ <i>Bayero</i> transiit --	38 55 20
30 9	23 27	Leonis $\sigma$ transiit	40 17 30
35 18	28 36	Leonis 16 <sup>ta</sup> <i>Cat. Brit.</i> transf.	38 21 20
47 8	40 26	Leonis $\nu$ transiit	37 40 30
52 42	46 00	Saturni centrum transiit	36 32 50
11 57 25	50 43	Cor Leonis transiit	38 7 5
12 0 35	53 53	Leonis 31 <sup>ma</sup> transiit	36 42 50
5 40	11 58 58	Leonis 34 <sup>ta</sup> transiit	36 19 30
12 10 50	12 4 8	Leonis 38 <sup>va</sup> transiit	35 3 50
		Ascensio recta $^h$ 147 4 45	
		Distant a Polo 75 5 00	
		Longitudo $\Omega$ 24 14 8	
		Latitudo Bor. 1 32 16	
Die Veneris Februarii 6.			
8 22 53	8 14 43	Lucidus pes Pollucis, $\pi\gamma$ tr.	34 52 00
11 29 22	11 21 12	Leonis $\downarrow$ transiit	36 9 15
11 43 58	11 35 48	Leonis $\nu$ transiit	37 40 30
11 49 10	11 41 0	Saturni centrum transiit	36 31 00
		Ascensio recta $^h$ 146 59 0	
		Distantia a Polo 75 3 10	
		Longitudo $\Omega$ 24 8 17	
		Latitudo Bor. 1 32 8	
Die Mercurii Febr. 18.			
11 0 15	10 53 0	Saturni centrum transiit --	36 12 00
11 8 53	11 1 38	Cor Leonis transiit	38 7 5
11 17 7	11 9 52	Leonis 34 <sup>ta</sup> <i>Cat. Brit.</i> transf.	36 19 35
11 22 16	11 15 1	Ejusdem 38 <sup>va</sup> transiit	35 3 55
		Ascensio rect. $^h$ 146 5 00	
		Distantia a Polo 74 44 10	
		Longitudo $\Omega$ 23 12 47	
		Latitudo Bor. 1 32 41	

Temp. per Tempora Horolog. correcta.				Die Lunæ Martii 2. 1713.				Distantiæ a Vertice			
h.		h.		h.		h.		°		°	
10	6	30	9	52	3	Leonis ♄ transit	36	9	30		
	19	27	10	5	00	Saturni centrum transit	35	55	20		
	31	21		16	54	Cor Leonis transit	38	7			
	34	31		20	4	Leonis 3 <sup>ma</sup> transit	36	42	50		
10	39	35	10	25	8	Leonis 3 <sup>ta</sup> transit.	36	19	40		
				Ascensio recta h 145 16 00							
				Distant. a Polo 74 27 30							
				Longitudo ♄ 22 22 40							
				Latitudo Bor. 1 3 52							

Die Martis Aprilis 7.											
7		43		1		7		41		15	
		50		46				49		00	
		57		35				55		50	
8		6		39		8		4		53	
		16		7				14		21	
8		21		17		8		19		31	
				Leonis ♄ transit				36 9 25			
				Saturni centrum transit				35 31 10			
				Leonis v Bayero transit				37 40 20			
				Leonis in collo n transit				33 19 25			
				Ejusdam 3 <sup>ta</sup> Cat. Br. trans.				36 19 30			
				Ejusdem 3 <sup>va</sup> transit				35 3 50			
				Ascensio recta h 143 57 45							
				Distantia a Polo 74 3 15							
				Longitudo ♄ 21 3 32							
				Latitudo 1 31 20							

Die Mercurii Aprilis 8.											
7		47		43		7		46		00	
		54		34				52		51	
8		3		37		8		1		54	
		13		4				11		21	
8		18		14		8		16		31	
				Saturni centrum transit				35 31 15			
				Leonis v transit				37 40 20			
				Leonis n transit				33 19 20			
				Leonis 3 <sup>ta</sup> transit				36 19 35			
				Leonis 3 <sup>va</sup> transit				35 3 45			
				Ascensio recta h 143 57 30							
				Distantia a Polo 74 3 20							
				Longitudo ♄ 21 3 20							
				Latitudo 1 31 10							
Saturno pene stationario											

Die
-----

Temp. per Horolog.	Tempora correcta.	Die Jovis Novemb. 5. 1713.	Diffa iæ a Vertice
h. ' "	h. ' "		° ' "
18 22 00	18 15 37	Leonis $\pi$ in genu seq. transiit	42 4 00
30 8	23 45	Cor Leonis transiit	38 7 5
54 35	48 12	Leonis in Axilla $\rho$ transiit	40 42 0
19 11 5	19 4 42	Leonis in ventre $\iota$ transiit	39 25 15
19 26 23	19 20 00	Saturni centrum transiit	42 10 40
		Ascensio rect. $\hbar$ 162 23 20	
		Distantia à Polo 80 43 00	
		Longitudo $\propto$ 10 13 40	
		Latitudo Bor. 1 39 37	

### Observationes JOVIS.

Anno MDCCXIII.

Temp. per Horolog.	Tempora correcta.	Die Solis Augusti 9.	Distantiæ a Vertice.
h ' "	h ' "		° ' "
12 40 4	12 37 27	Aquarii $\lambda$ in effusione A. } quæ transiit	60 32 50
12 48 37	12 46 0	Jovis centrum transiit	60 48 35
12 52 36	12 49 59	Aquarii 73 <sup>ta</sup> Cat. Brit. } prima ad $h$ transiit	60 46 20
13 4 21	13 1 44	Aquarii in aqua $\propto$ transiit	60 49 10
		Ascens. rect. $\propto$ 341 33 5	
		Dist. a Polo Bor. 99 21 40	
		Longitudo $\propto$ 9 26 00	
		Latitudo Aust. 1 25 8	

Die

Temp. per Horolog.	Tempora correcta	Die Lunæ Augusti 10. 1713.	Distantiæ a Vertice.
h. ' "	h. ' "		° ' "
12 36 21	12 33 55	Aquarii $\lambda$ transit	60 32 50
12 44 26	12 42 00	Jovis centrum transit	60 52 00
12 48 53	12 46 27	Aquarii 73 <sup>ia</sup> transit	
		Ascens. rect. $\times$ 341 26 5	
		Distant. a Polo 99 25 5	
		Longitud. Jov. $\times$ 9 18 17	
		Latitudo Aust. 1 25 40	
Die Lunæ Octobris 26.			
7 29 16	7 28 42	Aquarii in Clune $\sigma$ transit	63 34 40
7 36 34	7 36 0	Jovis centrum transit	63 00 5
8 14 34	8 14 0	Aquarii 8 <sup>oma</sup> prima ad $\downarrow$ tr	62 5 20
8 17 45	8 17 11	Aquarii 8 <sup>ta</sup> seq. ad $\downarrow$ trans.	62 37 5
		Ascensio recta $\times$ 335 41 30	
		Distantia a Polo 101 33 20	
		Longitudo Jovis $\times$ 3 16 00	
		Latitudo Aust. 1 19 8	
Die Martis Octob. 27.			
7 25 40	7 23 34	Aquarii Clunis $\sigma$ transit	63 34 35
7 33 6	7 31 00	Jovis centrum transit	62 59 15
8 11 00	8 8 54	Aquarii prima ad $\downarrow$ transit	62 5 15
8 14 10	8 12 4	Sequens ad $\downarrow$ transit	62 37 10
		Ascensio rect. $\times$ 335 43 20	
		Distantia a Polo 101 32 30	
		Longitudo $\times$ 3 17 58	
		Latitudo Aust. 1 19 00	
Die Jovis Octob. 29.			
7 18 29	7 15 19	Aquarii $\sigma$ transit	63 34 40
26 10	7 23 00	Jovis centrum transit	62 57 20
8 3 47	8 0 37	Prima ad $\downarrow$ transit	62 5 20
6 55	8 3 45	Sequens ad $\downarrow$ transit	62 37 10
2	A a a	Ascen.	

Die Jovis Octob. 29.  
 Ascensio recta  $\approx$  335 47 45  
 Distantia a Polo 101 30 35  
 Longitudo Jov.  $\times$  3 22 41  
 Latitudo Aust. 1 18 49

*Observationes MARTIS.*  
 Anno MDCCXIII.

Temp. per Horolog.	Tempora correcta.	Die Mercurii Feb. 18. 1713.	Distantiæ a Vertice
h. ' "	h. ' "		° ' "
12 28 38	12 21 20	Leonis in poplite $\tau$ transit	47 2 15
12 51 6	12 43 48	In ancone Alæ $\mu$ $\beta$ transit	48 5 40
13 10 21	13 3 3	Virginis 10 <i>ma Cat. Brit. r tr.</i>	47 57 40
13 13 18	13 6 00	Martis centrum transit	47 2 5
13 21 8	13 13 50	In cervice Virginis $\epsilon$ transit	46 33 30
		Asc. rect. <i>Martis</i> 179 29 20	
		Distantia à Polo 85 34 35	
		Longitudo $\mu$ 27 46 00	
		Latitudo Bor. 3 51 10	
Die Martis Martii 3.			
11 55 52	11 53 2	In vertice Virginis $\nu$ trans.	43 20 00
12 4 50	12 2 00	Martis centrum transit	45 14 20
10 54	8 4	In vultu Virginis $\pi$ transit	43 15 25
20 8	17 18	Undecima Virginis $\delta$ transit	44 3 30
12 30 25	27 35	Virginis 16. in Cervice $\epsilon$ tr.	46 33 25
12 32 37	29 47	Virginis 17 <i>ma Cat Br trans.</i>	44 33 45
		Asc. rect. <i>Martis</i> 175 1 15	
		Dist. a Polo Bor. 83 46 45	
		Longitudo $\mu$ 22 57 33	
		Latitudo Bor. 3 43 37	

Temp. per Horolog.	Tempora correcta.	Die Martis Aprilis 7. 1713.		Distantia a Vertice
h. ' "	h. ' "			° ' "
9 4 47	9 3 10	Sub Ventre Leonis $\propto$ transiit		42 35 25
9 17 37	9 16 00	<i>Martis</i> centrum transiit		42 42 50
9 38 10	9 36 33	Prima Virg. Cat. Br. $\omega$ transiit		41 44 50
9 45 00	9 43 23	Boreā in Vertice $\eta$ $\xi$ transiit		41 37 15
		Asc. rect. <i>Martis</i> 165 45 40		
		Distantia a Polo 81 15 10		
		Longit. <i>Martis</i> $\eta$ 13 30 40		
		Latitudo Bor. 2 26 31		

Die Mercurii Aprilis 8.				
9 1 44	9 0 29	Leonis $\propto$ transiit		42 35 30
9 14 15	9 13 00	<i>Martis</i> centrum transiit		42 43 40
9 35 7	9 33 52	Virginis $\omega$ transiit		41 44 55
9 41 58	9 40 43	Virginis $\xi$ transiit		41 37 15
		Asc. rect. <i>Martis</i> 165 41 00		
		Distantia a Polo 81 16 00		
		Longitud. <i>Martis</i> $\eta$ 13 26 45		
		Latitudo Bor. 2 23 58		

Die Veneris Maii 1.				
7 55	9 7 50	00 <i>Martis</i> centrum transiit		44 17 30
8 18 12	8 13 3	In Vertice Virginis $\nu$ transiit		43 20 00
8 33 14	8 28 5	In Vultu Virginis $\pi$ transiit		43 15 30
		Asc. rect. <i>Martis</i> 166 59 40		
		Distantia a Polo 82 49 50		
		Longitudo $\eta$ 15 15 00		
		Latitudo Bor. 1 27 40		

( 292 )

Temp. per Horolog.	Tempora correcta.	Die Saturni Maii 2. 1713.	Distantiæ a Vertice.
h ' "	h ' "		° ' "
7 52 45	7 47 00	Martis centrum transiit	44 24 20
8 15 7	8 9 22	Virginis $\nu$ transiit	43 20 5
8 30 8	8 24 23	Virginis $\pi$ transiit	43 15 25
		Afc. rect. Martis 167 10 00	
		Distantia a Polo 82 56 40	
		Longitudo $\pi$ 15 27 5	
		Latitudo Bor. 1 25 20	

# *Observationes L U N Æ.*

Anno MDCCXIII.

Die Solis Januarii 25.			
8 9 33	8 7 23	Telescopica $\alpha$ transiit	28 26 20
8 15 5	8 12 55	Tauri 123 <sup>a</sup> Cat. Brit. transiit	27 2 30
8 20 20	8 18 10	Lunæ limbus præced. } transiit, centro a Vertice }	27 32 40
8 21 23	8 19 13	Lunæ centrum transiit lim- } bo remoto a Vertice }	27 47 40
8 22 52	8 20 42	Lunæ cuspis Bor. a Vertice	27 17 40
8 30 15	8 28 5	Geminorum $\pi$ <del>90</del> $\pi$ transiit	28 13 20
8 41 7	8 38 57	Pes Castoris $\eta$ transiit	28 54 50
8 49 8	8 46 58	Calx ejusdem $\mu$ transiit	28 50 40
		Afc. rect. cent. $\gamma$ 84 26 55	
		Dist. a Polo visa 66 4 40	
		Sed adhibet. Paral. 65 39 50	
		Longit. Lunæ $\pi$ 24 56 30	
		Latitudo Bor. 0 57 00	

Temp. per Horolog.	Tempora correcta.	Die Lunæ Januarii 26. 1713.	Distantiæ a Vertice
h. ' "	h. ' "		° ' "
8 26 41	8 24 36	Propus transiit	28 13 30
8 37 31	8 35 26	Pes Castoris $\pi$ transiit	28 54 50
8 45 31	8 43 26	Calx Castoris $\mu$ transiit	28 50 40
9 9 43	9 7 38	Lunæ limbus præcedens } transiit, centro a Vertice }	28 45 00
9 10 50	9 8 45	Lunæ centrum trans. lim- } bo remoto a Vertice }	29 0 5
9 12 30	9 16 25	Lunæ cuspis Bor. a Vertice	28 30 10
9 27 50	9 25 45	$\pi$ orum <sup>46ta Cat. Br.</sup> trans.	28 26 10
9 42 44	9 40 39	$\pi$ orum in Inguine $\delta$ trans.	28 59 30
		Afc. rect. cent. $\gamma$ 97 43 50	
		Dist. a Polo visa 67 17 5	
		Adhibitâ Parallaxi 66 51 15	
		Longit. Lunæ $\odot$ 7 6 18	
		Latitudo Aust. 0 8 48	

### Observationes SATELLITUM JOVIS.

Die Veneris Octob. 30.

6 56 30	6 52 35	Quartus Satelles visus est emergens ab umbra, diametro Jovis distans a <i>tertio</i> ei proximo ad dextram, Tubo scilicet octo pedum.
7 4 00	7 00 00	Clare explenduit, & linea ducta a proximo illo per centrum Jovis emergentem reliquit ad Austrum, <i>situ scilicet inverso</i> .
7 36 31	7 32 30	Pegasi $\mu$ transiit per planum Arcus meridionalis.

Die Saturni Novemb. 7.

7 13 2	7 5 00	Secundus Satelles emergebat, vel potius emergere incipiebat. Tubo octo pedum
2 5 11	8 57 00	Piscium $\delta$ in Lino australi transiit. N.B.



N.B. *Stella illa Telescopica a qua die Januarii 25<sup>o</sup> Lunam precessit, Ascensionem rectam tunc habuit 81° 28'  $\frac{1}{2}$ , & distabat a Polo 66° 58' 20'', unde fit Longitudo ejus  $\pi$  22° 9'  $\frac{1}{2}$  cum Latitudine Australi 0° 13'  $\frac{1}{2}$ . Hæc autem est ea ipsa stella ad quam applicabatur Jupiter in Statione secunda, anno 1634 Februarii 6, eamque non nisi tribus sui corporis diametris ad Austrum reliquit, observante Gassendo: ut habetur inter Observata ejus pag 174. Et ad eandem Mars observatus est Septembris 6to anno 1644 mane, ut videre est in Prolegomenis Selenographiæ Hevelianæ pag. 65 & Fig. 1. Verum multum usui erit, ad accuratam Nodi Jovis determinationem, ejusque motus, si modo inter stellas fixas planum orbitæ Jovialis non hæreat immobile. Etenim post decursum 83 annorum, quibus Jupiter satis accurate septem absolvit periodos, anno scilicet 1717. Januarii 10. mane, Planeta stellam illam corporaliter teget vel saltem stringet, spectaculo quidem raro neque hætenus quod sciam Astronomis in Jove concessso.*

*Stella autem ipsa, etiamsi Telescopica vocetur, sudo cælo & absente Lunâ inermis oculi aciem non fugit; comitemque habet sequentem ad Austrum, & semidiametro Solis circiter distantem, apud quam conspicietur Jupiter arctissime conjunctus, Die vicesimo Julii anni proximi 1716 mane.*

IV. *An Account of an Experiment made by Dr. Brook Taylor assisted by Mr. Hawkesbee, in order to discover the Law of the Magnetical Attraction.*

**B**Y Order of the Royal Society Mr. *Hawkesbee* and my self made an Experiment with the great Loadstone belonging to the Royal Society, in order to discover the Law of the Magnetical Attraction; and not long  
 2 after

after I gave an account of it to the Society in a Letter to Dr. *Sloane*, (who was then Secretary) dated *June 25. 1712.* Since that, Mr. *Hawkesbee* made another Experiment of the same nature with a smaller Loadstone; which he has given an account of in the *Philosophical Transactions* No. 335. But upon comparing the Numbers of that Experiment with those of the other, I find the Numbers of the first Experiment to be very much more regular. Wherefore I conclude that to be the best Experiment, and since no notice has been taken of the Account I gave of it, and I have reason to believe Mr. *Hawkesbee* lost the Table I left with him for the Society, of the Numbers relating to it, I take this occasion to present the Society with the following Account of it.

We placed the great Loadstone belonging to the Royal Society so, that it's two Poles lay in the Plane of the Horizon, and were in a Line exactly at right Angles with the natural Direction of the Needle we made use of, (which was that Dr. *Halley* had made to observe the Variations with). And by means of a Carriage contrived for that purpose, the Stone was easily moved to and fro, the Poles continuing always in the same Line. The Needle was so placed, that the Center it play'd upon was in the same Line with the Poles of the Stone; the North Pole being towards the Needle. We measured the Distances from the Center of the Needle to the Extremity of the Stone; and we found the Variations of the Needle from its natural Position to be as in the following Table.

Distant. Feet	Variat.	Distant. Feet	Variat.	Distant. Feet	Variat.
1	81 45	4	16 0	7	3 30
2	58 00	5	9 20	8	2 20
3	30 00	6	5 35	9	1 35
					V. A

V. *A short Account of the Cause of the Saltness of the Ocean, and of the several Lakes that emit no Rivers; with a Proposal, by help thereof, to discover the Age of the World. Produced before the Royal-Society by Edmund Halley, R. S. Secr.*

There have been many Attempts made and Proposals offered, to ascertain from the Appearances of Nature, what may have been the Antiquity of this Globe of *Earth*; on which, by the Evidence of Sacred Writ, *Mankind* has dwelt about 6000 Years; or according to the *Septuagint* above 7000. But whereas we are there told that the Formation of *Man* was the last Act of the *Creator*, 'tis no where revealed in Scripture how long the *Earth* had existed before this last Creation, nor how long those five Days that preceeded it may be to be accounted; since we are elsewhere told, that in respect of the Almighty a thousand Years is as one Day, being equally no part of *Eternity*; Nor can it well be conceived how those Days should be to be understood of natural Days, since they are mentioned as Measures of Time before the Creation of the Sun, which was not till the Fourth Day. And 'tis certain *Adam* found the *Earth*, at his first Production, fully replenished with all sorts of other *Animals*. This Enquiry seeming to me well to deserve Consideration, and worthy the Thoughts of the *Royal Society*, I shall take leave to propose an Expedient for determining the Age of the World by a *Medium*, as I take it, wholly new, and which in my Opinion seems to promise success, though the Event cannot be judged of till after a long Period of Time; submitting the same to their better Judgment.

ment. What suggested this *Notion* was an Observation I had made, that all the *Lakes* in the *World*, properly so called, are found to be *Salt*, some more some less than the Ocean Sea, which in the present case may also be esteemed a *Lake*; since by that term I mean such standing Waters as perpetually receive Rivers running into them, and have no Exite or Evacuation.

The Number of these Lakes, in the known Parts of the World is exceeding small, and indeed upon Enquiry I cannot be certain there are in all any more than four or five, *viz.* first, The *Caspian Sea*; secondly, The *Mare Mortuum* or *Lacus Asphaltites*; thirdly, The Lake on which stands the City of *Mexico*, and fourthly, The Lake of *Titicaca* in *Peru*, which by a Channel of about fifty Leagues communicates with a fifth and smaller, call'd the Lake of *Paria*, neither of which have any other Exite. Of these the *Caspian*, which is by much the greatest, is reported to be somewhat less salt than the Ocean. The *Lacus Asphaltites* is so exceedingly Salt, that its Waters seem fully sated, or scarce capable to dissolve any more; whence in Summer-time its Banks are incrustated with great Quantities of dry Salt, of somewhat a more pungent nature than the *Marine*, as having a Relish of *Sal Armoniac*; as I was informed by a curious Gentleman that was upon the place.

The *Lake of Mexico* properly speaking is two Lakes, divided by the *Causways* that lead to the City, which is built in Islands in the midst of the *Lake*, undoubtedly for its Security; after the Idea, tis probable, its first Founders borrowed from their *Beavers*, who build their Houses on Damms they make in the Rivers after that manner. Now that part of the *Lake* which is to the Northwards of the *Town* and *Causways*, receives a River of a considerable magnitude, which being somewhat higher than the other, does with a small Fall exonerate it self in the Southern

part, which is lower. Of these the lower is found to be salt, but to what degree I cannot yet learn; though the upper be almost fresh.

And the Lake of *Titicaca*, being near eighty Leagues in circumference, and receiving several considerable fresh Rivers, has its Waters, by the Testimony of *Herrera* and *Acosta*, so brackish as not to be potable, though not fully so salt as that of the Ocean; and the like they affirm of that of *Paria*, into which the Lake of *Titicaca* does in part exonerate it self, and which I doubt not will be found much saltier than it, if it were enquired into.

Now I conceive that as all these Lakes do receive Rivers and have no *Exite* or Discharge, so 'twill be necessary that their Waters rise and cover the Land, until such time as their Surfaces are sufficiently extended, so as to exhale in Vapour that Water that is poured in by the Rivers; and consequently that Lakes must be bigger or lesser according to the Quantity of the fresh they receive. But the Vapours thus exhaled are perfectly fresh, so that the saline Particles that are brought in by the Rivers remain behind, whilst the fresh evaporates; and hence 'tis evident that the Salt in the Lakes will be continually augmented, and the Water grow saltier and saltier. But in Lakes that have an *Exite*, as the Lake of *Genesaret*, otherwise call'd that of *Tiberias*, and the upper Lake of *Mexico*, and indeed in most others, the Water being continually running off, is supply'd by new fresh river Water, in which the saline Particles are so few as by no means to be perceived.

Now if this be the true Reason of the Saltiness of these Lakes, 'tis not improbable but that the Ocean it self is become salt from the same Cause, and we are thereby furnished with an Argument for estimating the Duration of all Things, from an Observation of the Increment of Saltiness in their Waters. For if it be observed what Quantity of Salt is at present contained in a certain Weight of the

Water of the *Caspian Sea*, for example, taken at a certain Place, in the dryest Weather; and after some Centurys of Years the same Weight of Water, taken in the same place and under the same Circumstances, be found to contain a sensibly greater Quantity of Salt than at the time of the first Experiment, we may by the Rule of Proportion, take an estimate of the whole time wherein the Water would acquire the Degree of Saltness we at present find in it.

And this Argument would be the more conclusive, if by a like Experiment a simular Encrease in the Saltness of the *Ocean* should be observed: for that, after the same manner as aforesaid, receives innumerable Rivers, all which deposite their saline Particles therein; and are again supplied, as I have elsewhere shewn, by the *Vapours* of the *Ocean*, which rise therefrom in Atoms of pure Water, without the least admixture of Salt. But the Rivers in their long Passage over the Earth do imbibe some of the saline Particles thereof, though in so small a Quantity as not to be perceived, unless in these their Depositories after a long Tract of time. And if upon repeating the Experiment, after another equal Number of Ages, it shall be found that the Saltness is further encreased with the same Increment as before, then what is now proposed as *Hypotheticall* would appear little less than Demonstrative. But since this Argument can be of no use to Ourselves, it requiring very great Intervals of time to come to our Conclusion, it were to be wished that the ancient *Greek* and *Latin* Authors had delivered down to us the degree of the Saltness of the Sea, as it was about 2000 Years ago: for then it cannot be doubted but that the Difference between what is now found and what then was, would become very sensible. I recommend it therefore to the *Society*, as opportunity shall offer, to procure the Experiments to be made of the present degree of Saltness of the Ocean, and of as many of these Lakes as can be

come at, that they may stand upon Record for the benefit of future Ages.

If it be objected that the Water of the *Ocean*, and perhaps of some of these *Lakes*, might at the first Beginning of Things, in some measure contain Salt, so as to disturb the Proportionality of the Encrease of Saltness in them, I will not dispute it : But shall observe that such a Supposition would by so much contract the Age of the World, within the Date to be derived from the foregoing Argument, which is chiefly intended to refute the ancient Notion, some have of late entertained, of the Eternity of all Things ; though perhaps by it the World may be found much older than many have hitherto imagined.

*Accounts of B O O K S.*

- I. *Linear Perspective, or a New Method of representing justly all manner of Objects, &c.* By Brook Taylor, L. L. D. and R. S. Secr. 8vo. London, 1715.

THE Author of this Book, finding the Art of Perspective to be very imperfect in the Books that have hitherto been publish'd on that Subject, thought it worth his while to consider the whole matter anew ; and from a careful Examination of the Principles this Art is founded upon, he has endeavoured to establish some Theorems, by means of which the Practice of it might be render'd more general and easy than has yet been done. In order to this, at first sight he found it necessary to make use of new Terms of Art ; the old ones seeming not to

be expressive enough of what is meant by them, and being adapted to too confined an Idea of the Principles of this Art. In the old Perspective the chiefest regard is had to the Ground Plane, that is, the Plane of the Horizon: from whence is derived the *Horizontal Line*, and by means of that Line the Representations of some Figures are found by good simple Constructions. But then the Figures in all other Planes are drawn by reducing them to the Horizontal Plane by means of Perpendiculars; which is an inartificial round-about way, makes a great Confusion of Lines, and is not capable of so much Exactness. This confined way of treating this Subject, proceeds from the strong Possession the Mind is bred up in of the Notions of Upwards and Downwards, which makes one apt to refer all other irregular Positions to those principal ones. But the Minds of all Artists should be drawn as much as can be from such confined Ways of thinking, and they should be taught to accustom themselves, as much as may be, to consider Nature in its general View, without minding those particular Relations which things have with respect to themselves. For this reason our Author has rejected the Term of *Horizontal Line*, because it confines the Mind too much to the particular consideration of the Horizontal Plane: but he considers all Planes alike, and all Figures as they are in themselves, without considering their Relation to us; leaving the Artist to do that, when he comes to apply the general Rules of practice to any particular Design.

This Treatise is very short, because the Author has confined himself only to give the general Rules of practice, leaving the Reader to himself or to a Master to find out particular Examples to exercise himself in. Yet he hopes he has omitted nothing that is material to the understanding of this Art in the full extent of it. The whole Book consists of five Sections.



The first Section contains an Explanation of the fundamental Principle of this Art, with the Definitions of the Terms, and four Theorems. The fundamental Principle of this Art, is, that the Representation of any Point is a Point on the Picture where it is cut by a Line drawn from the original Point really placed where it ought to seem to be, to the place of the Spectators Eye ; and consequently, the Representation of any Line is the Intersection of the Picture with a Surface made by drawing Lines from the place of the Spectator's Eye, to the several Points of the original Line to be represented, really placed where it ought to seem to be. For these Lines which come from the several Points of the original Object to be placed in its proper Situation, to the Spectator's Eye, are as so many visual Rays which make the Object sensible.

When a Right Line is continued *in infinitum*, the Visual Ray becomes at last parallel to it, and an Object of any given bigness, if it goes still further and further off on that Line, will at last seem to vanish ; and at that time the place of its Representation on the Picture is the Point where the Ray parallel to the original Line cuts the Picture. For this reason our Author has thought it proper to call that Point the *Vanishing Point* of such an original Line (and consequently of all others parallel to it (Def. 5.) And for the same Reason he calls that Line on the Picture a *Vanishing Line* (Def. 6.) which is produced by the Intersection of the Picture with a plane passing thro' the Spectator's Eye parallel to an original Plane. There are ten Definitions in all, but these are the principal. And in our Author's Method these Vanishing Points and Vanishing Lines are of great use for the Representation of any Line passing through its vanishing Point. (Prop. 1.) Having found the Representation of one Point in any Line, by any Method whatsoever, he finds the Representation of the whole Line by its vanishing Point, which he shews an easy

easy Way to find in Propp 6, 8, 12. which are in the second Section. And by this means he solves several Problems in Perspective, which it is not possible to do by the common Way, at least without a great deal of Difficulty, and a great Confusion of Lines. And by this Method he shews how the compleat Representations of any proposed Figures may be found, having given the Representation only of some principal parts of them. The second Section contains several Propositions to that purpose, shewing how to find the vanishing Points and Lines of proposed Lines and Planes, according to the several Circumstances proposed; and by the means of them, how to find the Representation of any given Figure. In the End of this Section there are some Examples, in the Description of the regular Solids and some other Figures.

The third Section shews how to find the Representation of the Shadows of all Objects.

The fourth Section shews how to find the Representations of the Reflexions of Figures made by polish'd Planes.

The fifth Section contains a few Propositions relating to the inverse Method of Perspective; or the manner of examining a Picture already drawn; so as to find out what Point the Picture is to be seen from, or having that given, to find what the Figures are which are described on the Picture.

Our Author has observed that there may be a very good Expedient made use of in painting of large Rooms and Churches, which is drawn from the Nature of those Rays which produce the Vanishing Points. This not being mention'd in the Book it self, he thinks it not improper to take notice of it here: The Expedient is this, Having some way or other found the Representation of one Point of a Line that is wanted in the Picture, to find the whole Line, pass a Thread stretch'd through the place of the Spectator's Eye, in a Direction parallel to the Direction the original

ginal Line ought to be in, and the Shadow of that Thread cast by a Candle, so as to pass through the given Point on the Picture will be the Representation sought. The reason of this Construction is, because the Rays of Light that pass from the Candle to the Thread so stretched, make the Plane which generates the Representation sought. (see Prop. 1.) And there may be other Expedients of the like nature gather'd from the same Principle.

---

## II. *DUCATUS LEODIENSIS,*

Or,

*The Topography of the ancient Town and Parish of LEEDS and Parts adjacent, in the County of YORK, &c. By Ralph Thoresby, Esq; Fellow of the Royal-Society, London. Fol. 1715.*

**T**H O' the diligent and curious Author of this Work do not professedly treat of any Place but the ancient Town and Parish of *Leedes*, and the *Regio Leodis*, or adjoining Territory called *Elmet*; yet not only the Preface is more general, relating to the County, but there are many Passages in the Book it self, wherein he takes occasion to insert the Pedigrees of such of the Nobility and Gentry, as have had any Estates within the prescribed Limits, tho' the chief Seat of the Family be distant; as esteeming all *Provinciales*, who have but *Domicilium in Provincia*: to some of these he hath premised several Descents from ancient Deeds yet remaining in the respective Families; and to most of those that are inserted in the Visitations in the College at Arms, *London*. he hath added the Dates from Original Deeds, Registers, &c. and continued them to the present time, which hath rendred it

it so acceptable to the learned Gentlemen of that Faculty, that Four Kings at Arms, and some eminent Heralds, have not only subscribed, but since their Perusal thereof, bought others for their absent Friends, expressing great satisfaction in that part of the Performance : as many learned Antiquaries have done in the other Parts relating to the Topography and Etymology of the Names of Places, &c. which he hath been very particular in, as finding the Name to be frequently a brief Description of the Place ; and hath been thereby enabled to discover the *Vestigia* of some considerable Antiquities, in the actual Survey that he made of those Places to render the Work more complete : He hath, by the ancient Names and the Situation of the places, been enabled to describe, in a very particular manner, the Transactions between the *Pagans* and Primitive *Christian Saxons*, relating to that noted Battle upon *Win-moor*, An. Dom 655. There are also many very considerable Benefactions, and stately Edifices erected of later times, particularly a magnificent *Church* built and endowed by Mr. *Harrison*; whose Nephew the Reverend Mr. *Robinson* hath most generously promis'd to endow another Church, which, it is hoped, will be shortly erected in that populous Town of *Leeds*, to the building of which several of the Magistrates, particularly Mr. *Milner* (who hath adorned the Market-place with a most noble Marble Statue of Her late Majesty placed in the Front of the *Guild-hall*) and other Inhabitants have subscribed very liberally. Here is also a Charity-School for an Hundred poor Children, who are clothed and taught here, &c.

But what relates more immediately to these *Philosophical Transactions*, is the annexed Catalogue of the Authors *Museum*, justly celebrated for *Antiquities* and for *natural* and *artificial Curiosities*. The Catalogue of the Coins and

Medals is surprizingly copious and valuable. To the ancient *Greek* and *Consular*, or *Family-Monies* of the *Romans*, he hath added above a thousand *Imperial*, several of which are noted by the learned Baron *Spanhemius* as very rare; and so likewise are those justly esteemed that relate more immediately to *Britain*, whether minted by the *Romans* or *Britains*. That of *Thor* with *Runic* Letters is inestimable, being the only known Piece in the World with those ancient Characters upon it. This was first deciphered by the Right Reverend Dr. *Nicholson* Lord Bishop of *Carlisle*, and after by Dr. *Hicks*, the two great Revivers of that sort of Literature. Upon which single Medal a learned Foreigner hath printed a distinct Treatise. \* And the ingenious Sir *Andrew Fountain* in his *Dissertatio Epistolaris* to the Right Honourable *Thomas* Earl of *Pembroke*, saith expressly “ *Numismatum omnium quæ aut*  
“ *Anglo-Saxonibus, aut Anglo-Danis in usu fuisse videntur,*  
“ *nullum notatu dignius est, quam id literis Runicis inscrip-*  
“ *tum, quod possidet vir genere & ingenio clarus Radulphus*  
“ *Thoresbeius, Leodiensis.*” Those of the *Saxon* Kings begin with a very choice one of *Edwin* the ancientest Coin of the *English* Nation, and of the first *Christian* King of *Northumberland*; and are succeeded by those of the *Danish* and *Norman* Lines, and continued to the present Age, in a great Variety of current Monies and Medals in Gold, Silver and Copper. Those of *Ireland* and the *English* Plantations in *America*, are interspers’d in the several Reigns: but those of *Scotland*, from the first of the *Alexanders*, are so numerous and valuable as to merit a particu-

---

\* De Argento insignito *Runis* seu literis Gothicis, &c. Sententia *Nicholai Kederi*, Regii Antiquitatum Collegii, quod *Helmiz* est, Assessoris, 4to 1703. Lipsiæ.

lar Description. All along are very instructive Directions how to distinguish the Kings of the same Name from one another, before the Numbers were added upon their Monies. The *Roman* Emperours and *Saxon* Kings being well engraved before, the chief Defect and Difficulty is in those from *William I.* to *Henry VII.* which are therefore delineated here from the Originals. To these are prefixed the most ancient Consular Monies, which many Ages preceeded the Incarnation of our Blessed Saviour, because never yet extant in any *English* Author. The other Medals and Monies of Popes, Emperours, Kings and Republicks, must be omitted for brevity's sake, tho' some of them (particularly that of the Siege of *Leyden* in *Pastboard*) be very rare.

The *Natural Curiosities* are ranked in the following Method, 1. *Human* Rarities, 2. *Quadrupeds*, Viviparous (multifidous and bifidous) and Oviparous, with an Account of certain Balls and Stones found in the Stomachs of several Animals. 3. *Serpents*. 4. *Birds*, Land and Water-Fowls with their Eggs. 5. *Fishes*, viviperous and oviparous, scaled and exanguious. 6. *Shells*, whirled and single, double and multiple. 7. *Insects*, with naked and with sheathed Wings, and creeping Insects. 8. *Plants*, which begin with *Dr. Nicolson's* Collection of above 800 dry'd Plants; the rest are reduced to the accurate Method of *Dr. Sloane*, in his *Cat. Plant. in Insula Jamaica*, proceeding from the Corals and other Submarines to the Fruits and Parts of Trees. 9. *Formed Stones*, which are ranged according to *Mr. Llwyd's* curious Treat, *Lithophylac. Britan.* only to the Crystals and Diamonds are premised the *Margarite Cumbrenses*, some of which have as good a Water as the Oriental. After the fossile Shells and Stones of the turbinated Kind, the Bivalves and Shells amassed together into great Stones by a petrified Cement,

follow the Marbles and other Stones irregular. 10. The *Metals* Ores, Salts and Ambers, of which one with a Fly, another with a Spider enclosed.

The *Artificial* Curiosities relate to *War*, as *Indian* and *Persian* Bows, Arrows, Darts, Armour, Shields, Targets, Tomahaws, poisoned Daggers: to the *Mathematics*, to *Household-stuff*, *Habits*, &c. from the remotest Parts of the habitable World; not neglecting those that are obsolete of our own Nation. Then follow *Statues*, *Bass-Relieves*, *Seals*, Impressions, Copper-plates, Heathen Deities, Amulets, Charms and Matters relating to Romish Superstitions.

Of *enamel'd* Curiosities, that of General *Fairfax* and the fatal Battle at *Naseby* is perform'd with so exquisite Art, that it infinitely transcends the Metal, tho' Gold. And for *Paintings*, the *Misery of War* is admirably express'd, as to the various Passions, upon a Copper-plate about two Foot broad. To these may be added the Collection of printed Heads, and the *Effigies* of illustrious and learned Persons, beginning with the Royal-Family: then the Nobility, Warriours, Gentry, &c. in a Chronological Series. In the Ecclesiastical State, the Archbishops and Bishops are introduced by the Martyrs and Confessors of their venerable Order, and succeeded by other learned Dignitaries and pious Divines of both Denominations. The Judges are attended by the *Literati* in all Faculties, Physicians, Philosophers, Historians, Poets, Painters and other Artists. Some learned and pious Ladies are interspers'd. There are Volumes of the Saints, Popes, Emperors, and other Foreigners, amounting to the Number of 15 or 1600, many of which are done by the most celebrated Hands. Original *Designs* drawn by the *Pen* of noted *Virtuoso's*. *Writings* and *Drawings* by the Blind or Lame, as born without Hands. Some by other persons  
so

so admirably small yet legible, that in one there are 21, in another 28 Lines in the compass of an Inch. *Papers* of different Materials, Colour, Fineness, &c. ancient and modern: one Sheet of transparent Indian Paper a Yard in length. *Inkberns* from *Muscovia*, and *Turkey*, with Reed-pens painted and gilt. A *Turkish* Commission and Seal, a *Mancks* Warrant, the former impress'd with *Ink* not *Wax*, the latter upon blew *Slate* not *Paper*. Books printed in seven several Languages that are spoken in the English Dominions, not including what may now be added by the Accession of His present Majesty. A Catalogue of the various Editions of the *Bible* in this Museum; of the *Concordances* also, and *Common-Prayer* Books in different Languages; of the *Manuscripts* also, it being considerably encreased since that inserted in the *Oxford* Catalogue anno 1697. To these are added a List of Books published in the Infancy of the Art of *Printing*, and others that later Controversies have rendred remarkable. And also a large Catalogue of *Autographs* begun of late Years by the Author, yet by his general Correspondence furnished with the Signs Manual of many of the Kings of *England* before the Reformation; and the proper Hand-Writing of every one since: with those of a vast Number of the Lords Spiritual and Temporal in several Reigns, and of the learned Authors, &c. The like also of foreign Potentates, Warriours, *Literati* &c. of these some are very remarkable, being subscribed by the Lords of the Privy Council at *Whitehall*, by the Lord President and Council at *Tork*, and the Lord Deputy and Council at *Dublin*, from Queen *Elizabeth's* Reign to the last Day of King *James II.* when the Warrant could not be executed. *Oliver Cromwell's* Instructions to the Lord *Faulconberg* when sent Ambassadour to the *French* King. The Warrants of the several Governments that so hastily supplanted one another in that Year of Confusion 1659, (which occasioned



ned the Restoration ) all under their proper Hands and Seals. To these he hath since added *Richard Cromwell's* original Letters Patents to dissolve the Parliament ; and another rare *Album* with many learned Hands, to those before mentioned. Then followeth a Catalogue of several *Manuscript Rolls, Letters Patents, Diploma's, Charters* and ancient Deeds of Gift to Religious Houses, which would be of use towards another Volume of the *Monasticon Anglicanum. Bede-Rolls, Dispensations, &c.* Lastly, a Description of other *Antiquities* here deposited, as *Roman Deities, Altars, Sepulchral Monuments, Urns* of different Forms and Colours, *Cornelian Signets, a Roman Triumph in Basse-Relieve*, and the Story of *Adonis* slain by a Boar. Besides these there are *Clay Coining-Moulds* for counterfeiting the *Roman Coyns* when currant, *Fibula Vestiaria, Rings* or Bracelets of Jett, tessellated Pavements, Lamps, Bricks with Inscriptions, of which one very instructive is mentioned in the *Oxford Edition of Livy.* To which are added *Brass-Swords* found in *England, Ireland* and the *Isle of Man ; British Arrowheads of Flint ; a Danish Sacrificing Mallet of Marble, Antique Spurs, Shields, &c.* of later Ages, tho' now antiquated. The Figures of many of these are very well engraven, as also the Churches and Prospects in the Book.

By the Appendix it appears what considerable Additions the indefatigable Author is continually making to this Musæum. A Medal of *Jo Kendall* is especially remarkable, because retrieving the Memory of that noted Warriour, representing his Head in a noble *Relievo*, who was *Turcopellerius* or Colonel of the Cavalry (which Office belonged to the *English Nation*) at the memorable Siege of *Rhodes*, when *Mahomet the Great* was worsted. To the *Autographs* is added one impressed with a *Stile* upon a *Palmetto Leaf*, and folded up as a missive Letter in the *East-Indies* by

by one *Timothy* a converted *Malabarian*. Through the whole Work he is particularly grateful, in writing the Names of his Benefactors that have sent him any Curiosities. And concludes with an account of *unusual Accidents* that have attended some Persons in their *Births, Lives, and Deaths*, of which many are very very remarkable, but I fear to be too tedious.

---

F I N I S.

---

L O N D O N: Printed for W. I N N Y S at the *Prince's Arms* in *St. Paul's Church-yard*. MDCCLXV.

---

## A D V E R T I S E M E N T.

Just Publish'd,

**M**ethodus Incrementorum Directa, & Inversa, Autore *Brook Taylor*, L. L. D. & R. S. Secr. In two Parts. In the first Part are explain'd the Principles of the New Incremental Method, and by the means of that the Method of Fluxions is more fully explain'd than has yet been done; it being shew'd how this Method is deduced from the former, by taking the first and last Ratio's of the nascent and evanescent Increments. In the second Part the Usefulness of these two Methods is set forth by several Examples, viz. 1. In the summing up of Arithmetical Serieses. 2. In finding all the figurate Numbers. 3. In the finding of Tangents, Rays of Concavity, and the Quadrature of all sorts of Curves. 4. The Catenaria. 5. The Velaria. 6. The Fornix. 7. The Vibration of a Musical String. 8. The Centers of Oscillation and Percussion. 9. The Density of the Atmosphere. 10. The Refraction of Light passing thro' the Atmosphere, 4to. Printed for *W. Innys* at the *Prince's Arms* in *St. Paul's Church Yard*.

An Account of this Book will be given in a following Transaction.

---

# PHILOSOPHICAL TRANSACTIONS.

For the Months of September and October, 1715.

## The CONTENTS.

- I. *Some Accounts of the late great Solar Eclipse on April 22. 1715. made. Communicated to the Royal-Society from abroad.*
  - II. *An Account of a Journey from the Port of Oratava in the Island of Tenerif to the Top of the Pike in that Island, in August last; with Observations thereon by Mr. J. Edchs.*
  - III. *Ventriculus cordis sinister stupendæ magnitudinis, lately communicated to the Royal-Society by James Douglass, M. D. and R. S. S.*
  - IV. *A ready Description and Quadrature of a Curve of the Third Order, resembling that commonly call'd the Foliate. Communicated by Mr. Abr. de Moivre, F. R. S.*
  - V. *An easy Mechanical Way to divide the Nautical Meridian Line in Mercator's Projection; with an Account of the Relation of the same Meridian Line to the Curvâ Catenariâ By J. Perks, M. A.*
- Account of Books.* I. *An Account of a Book entituled Methodus Incrementorum, Auctore Brook Taylor, LL. D. & R. S. Secr. By the Author,*
- II. *Ludovici Ferdinandi Marsilii, Dissertatio de Generatione Fungorum. Rom. 1714. 4to,*

I. *Some Accounts of the late great Solar Eclipse on April 22. 1715. mane. Communicated to the Royal-Society from abroad.*

Since the Publication of the large Account we gave in *Phil. Trans.* No. 343. of what was observed in *England*, and particularly at *London*, of this Eclipse, we have received from foreign Parts the following Observations; which seem not unworthy the Acceptance of the Curious. And first Mr. *John Edens*, who has obliged us with the following most particular Relation of the Pike of *Teneriff* and of the Ascent thereto, being on his Voyage to that Island, observed the Eclipse at Sea, in Latitude, by Observation  $34^{\circ}.20'$ , and Longitude  $0^{\text{h}}.54'$ . West from *London*, as he concluded by their Distance and Position from the Island *Forte ventura*, which they soon after fell with. He writes that it began at  $\text{vi}^{\text{h}}.49'$ . and ended at  $\text{vii}^{\text{h}}.47'$ . this latter very exactly, tho' not quite so nice as to the Beginning.

Had this Observer signified what Difference of Meridians there was found between the Place of Observation and the West End of *Forte ventura*, we might, without sensible Error, have concluded the true Longitude, not only of that Island, but also of the Pike of *Teneriff*, where *Our Geographers* and the *Dutch* have fixed their first Meridian. But this Gentleman being both able and desirous to render the Publick this sort of Service, we hope from him such further Observations as may put the matter past dispute. He adds that the greatest Darkeness was about  $\frac{1}{2}$  of the Sun's Diameter, or nine Digits on the North side.

From

From *Germany* we have received the following Accounts.

At *Nuremburg*.

The Beginning and greatest Obscurity could not be seen for Clouds, but the End happen'd at  $x^h. 10^{\frac{1}{2}}$ .

At *Hamburg*.

The Beginning was observed at  $viii^h. 57'$ . The greatest Obscurity at  $x^h. 5'. 30''$ , when  $x\frac{1}{2}$  digg. were darkned. The End could not be seen for Clouds.

At *Kiel in Holstein*.

The Beginning  $ix^h. 14'$ . The greatest Obscurity  $x^h. 19'. 20''$ , and the Quantity then eclipsed  $xi$  digg.  $20'$ . The End was at  $x^h. 29'$ .

At *Berlin*.

The Beginning could not be seen for Clouds, but the greatest Obscurity was at 22 min. past Ten, when  $xi$  digg. were eclipsed. The just End was at  $x^h. 34'$ .

At *Franckfort on the Meine*.

The Eclipse began at  $viii^h. 50'$ . The greatest Darkness at  $x^h. 11'$ , but perhaps should be  $x^h. 01$  min. the Digits being  $x$ . and 34 min. The End was observed at 10 min. past Eleven.

By whom these Observations were made, and with what Instruments, we are not as yet informed, but hope they may be exact enough to confirm the *Longitudes* of those several places, which are at present reasonably well known.

Since these there is lately come to Hand a *Dutch Print* entituled *Nouvelles Literaires*, publish'd at the *Hague*, wherein, pag. 404. 405, there is an Account of the Observation of this Eclipse at *Upsal* in *Sweden*, made by *M. Jo. Waller*, Professor of Mathematicks in that University, who was very careful to observe it exactly; the Times being verified by three Clocks perfectly agreeing with one another and with the Sun: but more especially

By a Quadrant of 5 Foot Radius for taking the Sun's Altitude. By this Instrument he has determined the Height of the Pole at *Upsall*  $59^{\circ}.51'54''$ . And by the same, a little before the Beginning of the Eclipse he found the Height of Sun  $39^{\circ}.36'.42''$ . his Clocks then shewing the Hour  $1x^h.47'.50''$ , which proves that they were very near the true Time. At  $x^h.58'.15''$ . the Altitude of the Sun being  $44^{\circ}.17'.29''$ , was the Beginning of the total Darkness, and at  $x^h.2'.24''$ . was the End thereof, *alto sole*  $44^{\circ}.29'.13''$ . so that here the Duration of the total Eclipse was  $4'.9''$ , and the Middle thereof but one third of a Minute after Eleven. And lastly the End is said to have happen'd about 4 Minutes before Noon, the Sun being  $45^{\circ}.42'.6''$ . high: But in this is a manifest Mistake, for it makes the Time of Emerfion, or from the Middle to the End, but  $55'.20''$ ; whereas being so near the Meridian, 'tis certain that this Emerfion was the greater part of the Duration of the whole Eclipse, and consequently more than an Hour. Perhaps the Times might be deduced from the Altitudes only, and then the Mistake might be in supposing the End so much before Noon as it was really after it. However, to prevent all Doubts, we have compared this Observation with what we observed of this Eclipse at *London*, and find that in the Latitude of  $59^{\circ}50'$ , the Place where the Middle of total Darkness was at  $x^h.0'.20''$ , was near 19 Degrees more Easterly than *London* (that is exactly in the Meridian of *Danzick*) and that the Eclipse began there at  $1x^h.52'\frac{1}{2}$ , and ended at  $x^h.10'$ . Wherefore the Duration could not be  $2^h.7'.50''$ , as the *Editor* of the said *Nouvelles* has publish'd; not considering that the Beginning could not be seen for Clouds, as in the very next Words he assures us.

As to the Darkness, it was such that they could scarce distinguish one another: and besides *Jupiter*, *Mercury* and *Venus*; of the Fixt Stars *Cassiopea*, *Capella*, *Oculus Tauri* and *Orion*, (*Sirius* not being yet risen) were visible. II.

II. *An Account of a Journey from the Port of Oratava in the Island of Tenerife to the Top of the Pike in that Island, in August last ; with Observations thereon by Mr. J. Edens.*

ON Tuesday August the 13th N. S. at Half an Hour past Ten in the Evening, I, in company of four more English and one Dutch-Man, with Horses and Servants to carry our Provision, together with a Guide (which is the same that has conducted all those that have been this Journey for many Years) set forward from the Port of *Oratava*. The Night being somewhat cloudy, and the Moon in the full at 12 the Night following.

At half an Hour past Eleven we came to the Town of *Oratava*, which is about two Miles from the Port, where we stopt for about half an Hour, to get walking Staves to assist us in our ascending the Steep of the Pike.

At One a-Clock on Wednesday Morning we came to the Foot of a very steep Rising, about a Mile and half above the Town of *Oratava*, where it began to clear up ; and we saw the Pike with a white Cloud covering the Top of it like a Cap.

At Two a-Clock we came to a plain place in the Road which the Spaniards call *Dornajito en el Monte verde* (the little Trough in the green Mountain) so call'd I suppose because a little below this Plain, on the Right hand as we went, there is a deep Hollow ; at the upper End of which Hollow, there is a Spout of Wood placed in a Rock, through which there runs very clear and cool Water, which comes from the Mountains ; and at a Descent a little lower than the Spout there is a Trough into which the Water comes.

E e e

At



At Three, after travelling a Road, which was sometimes pretty smooth and at other times very rough, we came to a little wooden Cross, by the Road side on the Left-hand, which the Spaniards call *la Cruz de la Solera* (The Cross of the *Solera*) A *Solera* is a long Pole with a Hole at each end, which the Spaniards use to draw Wood with, by fastning one end to the Wood and the other to the Oxen. This Cross was made with a Piece of a *Solera*, and for that reason is so call'd, but why it was set up in this place I can't tell, unless it was because somebody was kill'd thereabouts. At this place we also saw the Pike before us; and altho' we had come up hill quite from the Port, yet to our thoughts it seem'd almost as high here as when we were there, the white Cloud still hiding the greatest part of the Sugar-loaf.

After riding about half a Mile further, we came to the side of a Hill which was very rough and steep, (the place call'd *Caravala*; where are a great many Pine Trees that grow on both sides the Road for a great way, both on the Right-hand and the Left, one of which that was close to the Road, on the Right-Hand as we went, our Guide desir'd us to observe; it having a great Branch growing out, which with the Boughs that were upon it look'd like the Forepart of a Ship. And from the likeness this Tree has to a Ship I suppose the Place took its Name, for *Caravela* signifies an old-fashioned Vessel formerly much used in *Spain*, sharp before, ill shap'd every Way, and all the Masts stooping forwards; their Sails are all Mizzen Sails, that is, Triangular; they will lye nearer the Wind than other Sails, but are not so commodious to handle. Amongst these Trees, not a great Height in the Air, we saw the Sulphur discharge its self like a Squib or Serpent made of Gun-powder, the Fire running downwards in a Stream, and the Smoak ascending upwards from the place where it first took Fire; and like this we saw another,

ther, whilst we lay under the Rocks the next Night at *la Stancha*, part of the way up the Pike; But I could not observe whether either of them gave any Report as they discharg'd.

At three Quarters after Four we came to the Top of this high rough and steep Mountain, where grows a Tree which the Spaniards call *el Pino de la Merenda*, The Pine-Tree of the Afternoon's Meal. This is a large Tree, and is burnt at the Bottom, as having had Fires made against it; and in the burnt place there issues out Turpentine, a little of which I brought with me. At a few Yards distance from this Tree we had a Fire made, where we stay'd and baited our Horses, and breakfasted our selves. These Hills are very sandy, and there are a great many Rabbits which breed there; There is also much Sand found a great way up the Pike it self, and not a great way below the Foot of the Sugar-loaf, some of which I brought down with me.

At Three Quarters after Five we set forwards again, and at Half an Hour past Six came to the *Portillo*, which in Spanish signifies a Breach or Gap. We saw the Pike about two Leagues and a half before us, cover'd still with a Cloud at Top; and the Spaniards told us we were come about two Leagues and a half from the Port.

At half an Hour past Seven we came to *las Faldas*, that is the Skirts of the Pike; from whence all the way to *la Stancha*, which is about a Quarter of a Mile up from the Foot of the Pike, we rode upon little light Stones, for the most part not much bigger than ones Fist; and a great many not much broader than a Shilling: and if we kept the beaten Track which was used before, it was not so deep, but if we turn'd out of it the Horses went almost over their Feet. I lighted and made a Hole there, thinking to find how deep these little Stones lie, but could

not find the Bottom ; which makes me conclude they may cover the Ground for a great thickness.

There are a great many vast Rocks, some of them two Mile or thereabouts from the Foot of the Pike, which the *Pike-Man* told us was cast out from the Top of the Pike at the time it was a *Vulcano* ; many of them lye in Heaps of above three score Yards long, and I observ'd that the further these Rocks lye from the Foot of the Pike, the more like they are to the Stone of other common Rocks : But the nearer we went to the Pike we found them more black and solid ; and some of them, tho' not many, were glossy like Flint, and all extream heavy. Those that shone so, I suppose, retain'd their natural Colour, but there are some that look like Dross that comes out of a Smith's Forge, which without doubt was occasioned by the extream Heat of the place they came from.

Some of these great Rocks were thrown out of the *Caldera* or Kettle in the Top of the Pike ; and others from a Cave or Cistern which is a pretty way up the side of the Pike, and has by some been thought to have no Bottom, more of which I shall say anon.

At Nine on *Wednesday* Morning we arrived at *la Stancha*, about a Quarter of a Mile above the Foot of the Pike on the East-side, where are three or four large hard and solid black Rocks lodg'd : under some of these we put our Horses, and under others we lay down our selves to sleep, after having refresh'd our selves with a little Wine : and we had a Fire made in order to get our Dinner ready, where a Cook we took along with us both roasted and boyled our Meat and Fowls very well. We slept here for about two Hours, then rose again, and at about Two in the Afternoon went to dinner.

There are several Mountains that lye Eastward from the Pike at four or five Miles Distance, call'd the *Malp-fes*, and one more lying a little more to the Southward call'd

*la montaña de rejada* ; all which were formerly *Vulcanos*, tho' not so great as that of the Pike, as appears by the Rocks and small burnt Stones that lye near them, just in the same manner as about the Pike.

Still being at *la Stancha*, after we had dined we lay down again to take a Nap. under the Rocks as before Dinner, but not sleeping very well we all got up again, the rest of them spending the Afternoon at *Cardis, &c.* But I made it my business to admire the strangeness and vastness of that great Body, which indeed is very wonderful, insomuch that its impossible to express to one that has never seen it, in what a manner that confused Heap of Rubbsh lyes; for it may very well be stiled one of the greatest Wonders in the World. About Six at Night we saw *Grand Canaria* from *la Stancha* bearing from us *E.* by *N.*

At Nine at Night, after having had our Suppers, we retired to our former Lodgings, where laying Stones for our Pillows and our Cloaks for Bed-cloaths, we endeavoured to get to sleep, but all in vain for a great while. Some lying pretty nigh a Fire complain'd of being burnt on the one side and froze on the other (for the Air was very cutting and sharp) Others happening to lye in a place where there was a great many Fleas; though it be something strange that Fleas should be found there, the place being so cold in the Night: perhaps the Goats sometimes get under these Rocks and so leave them; and I am inclin'd to believe it, because the Guide and I found a dead Goat in a Cave at the very top of the Pike. I suppose this Goat straggling up here by chance was benighted, and so finding the Cold got into this place for Heat, where meeting with too much of it and a very strong Sulphurous Vapour it overcame him; for he was almost dryed to Powder. But to proceed, betwixt Eleven and Twelve we got to sleep, and slept till One, when waking, our Guide told

us 'twas time to prepare for our Journey. We immediately rose, and by half an Hour past One we were all upon the march, and leaving our Horses and some of our Men behind, we went away fasting, excepting about two Mouthfulls of Wine apiece, which we took at our uprising. Betwixt *la Stancha* and the Top of the Pike there are two very high Mountains and the Sugar-Loaf, each of which Mountains is almost half a Mile's walking: on the first of them the Rubbish is more small, and we were apt to slip back as we stept upwards. But the uppermost is all composed of hard loose rocky great Stones, cast one among another in a very confused Order. After resting several times we came to the Top of the first Mountain, where we drank every one of us a little more Wine, and eat each of us a Bit of Ginger-Bread we had amongst us. Then being pretty well refresh'd, we set forwards again to ascend the second Mountain, which is higher than the first, but is better to walk on because of the firmness of the Rocks. After we had travel'd for about half an Hour up the second Mountain, we came within sight of the Sugar-Loaf, which before we could not see by reason of the Interposition of these great Hills. After we were arriv'd to the Top of this second Mountain we came to a way that was almost level, but bearing some small matter up-hill; and about a Furlong farther is the Foot of the Sugar-Loaf, which we soon after came to. Then looking upon our Watches found it to be just three a-Clock. The Night was clear where we were, and the Moon shone very bright, but below over the Sea we could see the Clouds, which look'd like a Valley at a prodigious Depth below us. We had a brisk Air, the Wind being S. E. by S. as it was for the most part whilst we were upon our Journey.

Whilst we sat at the Foot of the Sugar-Loaf, resting and refreshing our selves as before in other places, we saw  
the

the Smoak break out in several places, which at first look'd like little Clouds, but they soon vanish'd, others not long after coming in their room from the same or other places.

We set forwards to ascend the last and steepest part of our Journey, *viz.* the Sugar-Loaf, exactly at half an Hour past Three, and after we had rested twice or thrice, I left the Guide and the rest of my Company, and ran forwards; and when I was got very nigh the Top (which was at three quarters after Three) two more of the Company deserted, and came up about Five Minutes after me; the rest of the Company and the Guide coming up to the Top just at Four.

The Shape of the Top of the Pike is partly oval, the longest Diameter lying *N. N. W.* and *S. S. E.* and is as high as I could guess, about 140 Yards long; the Breadth the other way being about 110. Within the Top of the Pike is a very deep Hole call'd the *Caldera* (or *Kettle*) the deepest part of which lyes at the *South* End: It is I believe 40 Yards deep, reckoning from the highest side of the Pike: but it is abundance shallower reckoning from the side opposite to *Garachica*. The sides of this Kettle are very steep, in some places as steep as the Descent on the outside of the Sugar-Loaf. At the Bottom of this Kettle we all were, where lye a great many very large Stones, some of them higher than our Heads. The Earth that is within side the Kettle, being roll'd up long and put to a Candle, will burn like Brimstone. Several places within side the Top of the Pike are burning, as on the Outside; and in some places if you turn up the Stones you'll find very fine Brimstone or Sulphur sticking to them. At these Holes where the Smoak comes out there also comes forth a great Heat, so hot that one cannot endure one's Hand there long. At the *N* by *E.* side within the Top is the Cave where we found the dead Goat; in which Cave

Sometimes the true Spirit of Sulphur distills, as they say, but it did not drop whilst I was there.

The Report is false about the Difficulty of breathing upon the Top of this place ; for we breath'd as well as if we had been below : we eat our Breakfast there, and I was up in all for about two Hours and a quarter.

Without doubt the Quicksilver would have fell very much upon this high place, if I had had but the good fortune to have got a couple of Barometer to try. But there is no such thing in this Island, and I was fearful of not getting Company in the mind to go up with me another Year (for to go up by ones self is very chargeable) else I would have sent to *England* to have been supply'd, tho' the Expence had come all out of my own Pocket.

Before the Sun rose I think the Air was as cold as I have known it in *England*, in the sharpest Frost I was ever in ; I could scarcely endure my Gloves off. There was a great Dew all the while we were there till Sun rising, which we could find by the Wetness of our Cloaths ; but the Sky look'd thereabouts as clear as possible.

A little after Sun rising we saw the Shadow of the Pike upon the Sea, reaching over the Island of *Gomera* ; and the Shadow of the upper part, viz. of the *Sugar-loaf*, we saw imprinted like another Pike in the Sky it self, which look'd very surprizing ; but the Air being cloudy below us, we saw none of the other Islands but *Grand Canaria* and *Gomera*.

At six on *Thursday* Morning we came down from the Top of the *Sugar-loaf* ; at seven we came to the Cistern of Water which is reported to be without Bottom : this the Guide says is false, for about seven or eight Years ago when there was a great *Vulcano* in this Country, the Cave was dry and he walk'd all about it, and said that the deepest part of Water, when we were there, was not above two Fathoms.

The Dimensions of this Cave I guess to be as follows

Length about 35 Yards

Breadth ——— 12

Ordinary Depth 14 from Top to Bottom.

Upon the furthest side grows white Stuff, which the *Pike-man* told us was Salt-Peter. There was both Ice and Snow in it when we were there : and the Ice was of a great Thickness covered with Water about Knee deep. We let down a Bottle at the End of a String for some of the Water, in which we put some Sugar and drank it, but it was the coldest I ever drank in my Life. The Ice was broken just under the Mouth of it, where we could see the Stones lye at the Bottom, for it was very clear. A little to the Right-hand within this Cave the Ice was risen up in a high heap, in form of a Spire Steeple or like a Sugar-Loaf ; and in this place I believe the Water comes in. I should have been glad to have come at it, to let down a Line to try whether there may not be some Hole that the Guide knows not of, that may be of a great Depth.

In our way home, we came by a Cave three or four Miles from the Pike, where are a great many Skeletons and Bones of Men ; and some say there are the Bones of Giants in this Cave, but we know not how many Bodies are laid here, nor how far the Cave may go. I intend (God willing) to go again before I leave the Island, and then I'll take a Light with me and see what Discoveries I can make.

We came home to the Port at about six a-Clock this Evening, being *Thursday August 15. 1715. N. S.*

Whoever reads this, I hope, will pardon the Faults my Pen may have committed, for I was forc'd to write all Night; the Ship being to sail the next Morning, and I have not time to examine it.



III. Ventriculus cordis sinister stupendæ magnitudinis, lately communicated to the Royal-Society by James Douglass, M. D. and R. S. S.

**I** Lately opened a young Man in St. Bartholomew's Hospital, that died of the Palpitation of the Heart, whose violent beating and prodigious subsultory Motion, for some Months before his Death, was not only easily felt by laying the Hand on the Region of the Heart ; but seen to rise and fall by raising the Bedcloaths that covered it. And, which is almost incredible, at sometimes the trembling and throbbing made such a Noise in his Breast, as plainly could be heard at some Distance from his Bed-side. This was accompanied with frequent *Deliquiums*, sometimes slow, sometimes swift, and often intermitting.

*Johannes Fernelius* in his *Pathologia* lib. 5. cap. 12. gives us an Observation of a very uncommon and surprising Case of this kind ; where he says the frequent Concussion of the Heart was so violent and powerfull, as not only to displace or luxate, but even to break some of the adjoining Ribs.

*Franciscus de la Boe Sylvius*, another Writer of unquestionable Integrity, has a parallel Observation in his Account of this Disease.

*Theodorus Kerkringius* relates the History of a Woman he opened, whose Heart was of a prodigious Bigness, in his *Spicilegium Anatomicum*, Obs. 16.

And to mention no more, *Monfieur Dionis*, at the End of his Anatomy, gives a large Description of a very uncommon Case, in which the right Auricle of the Heart was prodigiously dilated to the Bigness of the Head of a new born child.

In the Dissection of this morbid Heart I observed the following remarkable Particulars.

1. That the *Pericardium* or *Capsula Cordis* was very thick and firmly adhered or grew by a fibrous Connexion to all the outer Surface of the Heart.

2. Instead of the Water called *Liquor Pericardii*, there was only in some places about the *Basis* of the Heart a mucilaginous clear Substance like a Gelly.

3. In the right Auricle lay'd open there was nothing preternatural. The ascending and descending *Cava* opened into the same as usual. The *Vestigium* or Mark of the *Foramen ovale* with its semicircular *limbus* was very plain.

And the *Orificium* of the *Vena Cordis Coronaria* was extremely large, yet its Valve was less than usual.

4. In the right Ventricle layed open, the *Valvulae* called *tricuspidae* were configurate after the usual manner. The sides of this Cavity were thin and full of small fleshy *Columnae* as they commonly are, with great variety of Furrows and little holes. The three *sigmoide* or *semilunar Valves* in the Mouth of the *arteria pulmonalis*, were as they always are in a natural State.

5. The left Auricle was not much bigger than ordinary: but its muscular Appendage, called the *Bulb* of the *Pulmonary Vein* by the late Mr. *Comper*, was extraordinarily dilated and enlarged beyond any thing that I ever saw.

6. The left Ventricle, whose Capacity in a natural State is always less than the right, was here considerably larger. And if the Experiment had been made, before Dissection, of filling both with any Liquor, this had certainly contained three times more than the other.

7. The *Valvulae* called *Mitrales*, placed at the Orifice of this Ventricle, are much thicker in Substance than ordinary; and the two fleshy Columns, called by *Nicolaus Massa*, almost 200 Years ago, *duo parvi muscoli*, which send out

abundance of small Tendons to be inserted into the Valves, were proportionably augmented in Bigness.

8. The *semilunary Valves* in the Mouth of the *Aorta*, or of that great *Vena pulsatilis* that dispenses the Blood to all the several parts of the human Body, were very much preternaturally affected ; as would easily appear upon comparing them with those in the Orifice of the *pulmonary Artery*, in which they are thin and very broad, so as to be able to shut the Cavity of that Vessel. and hinder the Blood from returning back into the Ventricle, and likewise transparent : but in this they are very thick, contracted as it were, and furled together, and of a whitish Colour ; and in all appearance, if the Person had lived longer, they had turned boney or undergone a Petrification.

This uncommon Structure of the Heart being thus demonstrated, let us endeavour to account for the following Phenomena. The first is the Palpitation of the Heart, which was the chief Symptom and Complaint of the sick Person. The second is the preternatural Dilatation and Enlargement of the left Ventricle. It is not improbable but the firm adhesion of the *Capsula Cordis membranacea* to the substance of the Heart, occasioned that uncommon trembling and throbbing thereof : its free and easy Motion being hindered by that thick *involucrum* which surrounded it so close on each side. The learned Dr. *Lower*, in his elaborate Treatise *de Corde humano* gives us such an instance, and explains the Palpitation after this manner.

As for the second, *viz* the Dilatation of the left Ventricle and muscular Bag of the *Pulmonary Vein* ; that is altogether owing to the ill configuration of the *Valves* we have now described : for as the great Artery or *Aorta* arises out of this Ventricle, it has three Valves which separating give passage to the Blood from the Ventricle into

the Vessel; and in a natural State they shut that Passage, and so prevent the Blood from recoiling into the same, if it should endeavour to return. But in this case, by reason of its contracted Narrowness and Thickness, not being able to close or shut the Passage, the Blood flowd back again into the Cavity, which it had gradually enlarged, and dilated to the Bigness we see. Besides the *Muscular Valves* not being duly qualified for the Performance of their Office, the Blood recoiled into the *Auricle*, which it had distended in the like manner. This constant Regurgitation or Reflux of the Blood is besides sufficient of its self, to produce this extraordinary trembling or *παλμός καρδίας*, as the *Greeks* call it.

IV. *A ready Description and Quadrature of a Curve of the Third Order, resembling that commonly call'd the Foliate. Communicated by Mr. Abr. de Moivre, F. R. S.*

I Have look'd a little farther into that Curve which fell lately under my consideration. It is not the *Foliate* as I did at first imagine, but I believe it ought not to make a *Species* distinct from it. *AEB* (Fig. 1.) is the Curve I thus describe. Let *AB* and *BK* be perpendicular to each other. From the point *A* draw *AR* cutting *BK* in *R*, and make *RE = BR*, the point *E* belongs to the Curve Draw *BC* making an Angle of *45 grad.* with *AB*, this Line *BC* touches the Curve in *B*; from the point *E* draw *ED* perpendicular to *BC*, and calling *BD, x*; *DE, y*; *AB, a*; and making  $\sqrt{8aa} = n$ , the Equation belonging to that Curve is  $x^3 + xxy + xyy + y^3 = nxy$  or  $\frac{x^4 - y^4}{x - y} = nxy$  Taking *BG = AB*, and drawing *GP* perpendicular to *BG*, *PG* is an *Asymptote*. In the *Foliate*

the Equation is  $x^3 + y^3 = \frac{1}{2} n x y$ . in which the two Terms  $x x y$  &  $x y y$  of the former Equation are wanting; and its *Asymptote* is distant from  $B$  by  $\frac{1}{2} B A$ . Again draw  $E F$  perpendicular to  $A B$ : let  $B F$  be called  $z$  and  $F E$   $v$ ; the Equation belonging to the Curve  $A E B$  is  $v v = \frac{a z z - z^3}{a + z}$ . In the *Foliate* the Equation is  $v v = \frac{a z z - z^3}{a + 3 z}$

From these two last Equations it seems that these Curves differ no more from one another than the *Circle* from the *Ellipsis*. I should be very glad to know your Opinion thereupon.

The Quadrature of the Curve here described has something of Simplicity with which I was well pleased. With the Radius  $B A$  and Center  $B$  describe a Circle  $A K G$ , let the Square  $H P S T$  circumscribe it, so that  $H P$  be parallel to  $A G$ : prolong  $F E$  till it meet the Circumference of the Circle in  $M$ , and through  $M$  draw  $L M Q$  parallel to  $H P$ . The Area  $B F E$  is equal to the Area  $K H L M$ , comprehended by  $K H$ ,  $H L$ ,  $L M$  and the Arc  $K M$ . And the Area  $B f e$  is equal to the Area  $K m L H$  or  $K M P Q$ . Therefore if  $B F$  and  $B f$  are equal, the two Areas  $B F E$ ,  $B f e$  taken together are equal to the Rectangle  $H Q$ , and therefore the whole Space comprehended by  $B E A X B e T G Z$  (supposing  $T$  and  $Z$  to be at an infinite Distance) is equal to the circumscribed Square  $H S$ .

N.B. *This Quadrature is easily demonstrated from the Equation: for by it*  $a - z :: z :: z z :: v v$ , *that is*  $A F :: E F :: M F :: F B$ , *and so*  $\phi F$  *the Fluxion of*  $A F$  *to*  $L l$  *the Fluxion of*  $M F$ . *Hence the Arcola*  $E F \phi e$  *will be always equal to the Arcola*  $M L l \mu$ , *and therefore the Area*  $A E F$  *always equal to the Area*  $M A L$ .

Hence it appears that this Curve requires the Quadrature of the Circle to square it; whereas the Foliate is exactly quadrable, the whole Leaf thereof being but one third of the Square of  $A B$ , which in this is above three sevenths of the same. Again  
in

*In our Curve, the greatest Breadth is when the Point F divides the Line AB in extreme and mean Proportion: whereas in the Foliate it is when AB is triple in power to BF. And the greatest EF or Ordinate in the Foliate is to that of our Curve nearly as 3 to 4, or exactly as  $\sqrt{\frac{2}{3}} \sqrt{\frac{1}{3} - \frac{1}{3}}$  to  $\sqrt{5} \sqrt{\frac{5}{4} - 5 \frac{1}{4}}$ .*

*But still these Differences are not enough to make them two distinct Species, they being both defined by a like Equation, if the Asymptote SGP be taken for the Diameter. And they are both comprehended under the fortieth Kind of the Curves of the third Order, as they stand enumerated by Sir Isaac Newton, in his incomparable Treatise on that Subject.*

---

#### IV. *An easy Mechanical Way to divide the Nautical Meridian Line in Mercator's Projection; with an Account of the Relation of the same Meridian Line to the Curva Catenaria. By J. Perks, M. A.*

THE most useful Projection of the Spheric Surface of Earth and Sea for Navigation, is that commonly call'd *Mercator's*; tho' its true Nature and Construction is said to be first demonstrated by our Countryman Mr. Wright, in his *Correction of the Errors in Navigation*. In this Projection the Meridians are all parallel Lines, not divided equally, as in the common plain Chart (which is therefore erroneous,) but the Minutes and Degrees (or strictly, the *Fluxions of the Meridian*;) at every several Latitude are proportional to their respective *Secants*. Or a Degree in the projected Meridian at any Latitude, is to a Degree of Longitude in the Equator, as the *Secant* of the same Latitude is to *Radius*.

The Reason of which Enlargement of the Elements of Latitude is, to counterbalance the Inlargement of the Degrees of Longitude. For in this Projection, the Meridians being all parallel, a Degree of Longitude at (suppose) 60 Deg. Lat. is become equal to a Degree in the Equator, whereas it really is (on the Globes Surface) but *half* as much, the Radius of the Parallel of 60 Deg. (that is its *Cosine*) being but *half* the Radius of the Equator. Therefore to proportion the Degrees of Latitude to those of Longitude, a Degree (or Elemental Particle) in the Meridian, is to be as much greater than a Degree (or like Particle) in the Equator, as the Radius of the Equator is greater than the Radius of the Parallel of Latitude, *viz.* its *Cosine*.

In *Fig. 3<sup>rd</sup>* let the Radius *CD* represent half of the Equator, *DM* an Arc of the Meridian; *MS* its Sine, *CE* its Secant; then is *CS* equal to its *Cosine*: and  $CS : CM :: CD (= CM) : CE$ , that is, as *Cosine* : to *Radius* :: so is *Radius* : to *Secant*. The *Cosines* being then, in this Projection, suppos'd all equal to *Radius*, or (which comes to the same) the *Parallels* of Latitude being all made equal to the Equator, the *Radius* of the Globe, at every point of Latitude, (by the precedent Analogy) is supposed equal to the *Secant* of Latitude; and consequently the Elements (*Minutes, &c.*) of the Meridian must be proportional to their respective *Secants*,

The Way Mr. *Wright* takes for making his Table of *Meridional Parts*, is by a continual Addition of Natural *Secants*, beginning at 1 Minute, and so proceeding to 84 Deg. Dr. *Wallis* (in *Phil. Trans.* No. 176.) finds the *Meridional Part* belonging to any Latitude by this *Series*, putting *S* for its Natural Sine, *viz.*  $S + \frac{1}{2}S^3 + \frac{1}{4}S^5 + \frac{1}{6}S^7 + \frac{1}{8}S^9$  &c. which gives the *Merid. part* required. How to find the same Mechanically by means of an easily-constructed Curve Line, is what I shall now shew.

1. Prepare a Rular  $AB$  (*Fig. 2.*) of a convenient Length, in which let  $Bo$  be equal to the Radius of the intended Projection. To the Point  $o$  as a Center (on the narrower Edge of the Rular) fasten a little Plate-Wheel  $mh$  tight to the Rular, and of a Diameter a little more than the thickness of the Rular. Let  $KR$  (*Fig. 3.*) represent another long Rular, to which  $AR$  is a perpendicular Line. Place the Rular  $AB$  upon the Line  $AR$ , with the Center of the Wheel at  $A$ . Then with one Hand holding fast the Rular  $KR$ , with the other Hand slide the end  $B$  of the Rular  $AB$  by the Edge of  $KR$ ; so will the little Wheel  $mh$  describe on the Paper a Curve Line  $ACB$ , to be continued as far as is convenient.

2. Having drawn the Curve  $ACB$ , draw a straight Line  $K'R$  by the Edge of the Rular  $KR$ : which Line is the *Meridian* to be divided, and also an Asymptote to the Curve  $ACB$ .

3. In this Meridian, (accounting  $R$  to be the Point of its Intersection with the Equator,) the Point answering to any Degree of Latitude is thus found. In the perpendicular  $AR$ , make  $RG$  equal to the *Cofine* of Latitude (Radius being  $AR$ ), and from  $G$  draw  $GC$  parallel to  $KR$ , and intersecting the Curve in  $C$ . With Center  $C$  and Radius  $CM = AR$ , strike an Arc cutting the Meridian at  $M$ ; so is  $M$  the Point desir'd.

4. In the Curve  $AC$ , let  $c$  be a Point infinitely near to  $C$ , and  $cm$ , ( $= CM$ ), a Tangent to the Curve at  $c$ , making the little Angle  $MCm$ , to which let the Angle  $RAr$  be equal: so is  $Rr = Md$  (a Perpendicular from  $M$  to  $cm$ .) Draw  $CD$  equal and parallel to  $AR$ , intersecting  $KR$  in  $S$ . With Center  $C$  and Radius  $CD$  draw the Arc  $DM$ , and its Tangent  $DE$  and Secant  $CE$ .

5. Because of the like Triangles  $CDE$ ,  $Mdm$ ;  $CD : CE :: Md : Mm$ , that is, as Radius to Secant of the Arc  $DM$ , (whose Cofine is  $CS = GR$ ), :: so is  $Md$

G g g

( =



( =  $Rr$  a Degree or Particle of the Equator : ) to  $Mm$  the Fluxion or correspondent Particle of the Meridian Line  $RM$ . Whence, and from what is premised concerning the Nature of this Nautical Projection, 'tis evident that  $RM$  is the *meridional Part* answering to the Latitude whose Cosine is  $GR$ . Or thus ; With Center  $R$  and Radius  $AR$  describe the Quadrant  $A\alpha\alpha$ , in which let the Arc  $A\alpha$  be equal to the given Lat. From  $\alpha$  draw  $\alpha C$  parallel to  $KR$ , and intersecting the Curve in  $C$ , so is  $C\alpha$  the Meridional Part desir'd being equal to  $RM$ , as is easy to shew.

As to the other Properties of this Curve, 'tis evident, from its Construction, that its *Tangent* (as  $CM$ ) is a *Constant Line* every where equal to  $AR$ ; the Curve being generated by the Motion of the Wheel at the End of the Ruler which is its Tangent. And from hence the Curve  $ACB$  may, for distinction, be call'd the *Equitangential Curve*.

7. The Fluxion of the Area  $ARMC$  is the little Sector or Triangle  $MCd$ , which same is also the Fluxion of the Sector  $CDM$  : whence the Areas  $ARMC$ ,  $CDM$  are equal, and the whole Area  $ACB$  &  $c$ ,  $KMR$  being infinitely continued, is equal to the Quadrant  $AR\alpha$  :

8. To find the Radius of Curvature of any Particle, as  $Cc$ , from  $C$  draw an indefinite Line  $CT$  perpendicular to  $CM$ , (on the concave side of the Curve) and from  $c$  another Line perpendicular to  $cm$ , which Lines, (because of the Inclination of  $CM$  to  $cm$ ,) will somewhere meet as at  $T$ , making an Angle  $CTc = MCm$ . These Angles being equal, their Radii are proportional to their Arcs : therefore,  $Md : Cc :: MC : CT$ . But  $Cc = dm$  (because of  $CM = cm$ ) so that  $Md : dm (:: CD : DE) :: CM : CT$ . But  $CD = CM$ , therefore  $CT = DE =$  Tangent of the Arc  $DM$ .

9. So that supposing  $ATt$  a Curve Line in which are all the Centers of Curvature of the Particles of  $ACB$ , any point as  $T$  being found as before, the Length  $AT$  (by the nature of *Evolution of Curves*,) is every where equal to the *Tangent* of its correspondent Circular Arc  $DM$ . The Point  $T$  is also found by making  $MT$  perpendicular to  $RM$ , and equal to the Secant  $CE$ : for so is the Angle  $CMT = MCD$ ; and the Triangle  $MCT$  equal to the Triangle  $CDE$ .

10. Let  $AHh$  be an Equilater Hyperbola whose Semi-axis is  $AR$  and Center  $R$ . In the Meridian let  $RP$  be equal to the Tangent  $DE$ . Join  $AP$ , and draw  $PH = AP$  and parallel to  $AR$ . Compleat the Parallelogram  $HNR P$ , so will the Point  $H$  be in the Hyperbola, and its ordinate  $HN (= RP = DE = CT)$  be equal to the Curve  $ATt$ . From whence, and from *Prop. 3. Coroll. 2.* of *Dr. Gregory's Catenaria* (*Phil. Trans.* N. 231.) it appears that the Curve  $ATt$  is that call'd the *Catenaria* or *Funicularia*, viz. the Curve into whose Figure a *slack Cord* or *Chain* naturally disposes its self by the Gravity of its Particles.

“ 11. Hence we have another Property of the *Catenaria*  
 “ not hitherto taken notice of (that I know of,) viz. that  
 “ supposing  $AR (= a$ , the constant Line in *Dr. Gregory*)  
 “ equal to the *Radius* of the Nautical Projection, and  
 “  $RN$  the Secant of a given Latitude, then is  $NT$  the  
 “ *Catenaria's* Ordinate at  $N$ , equal to  $RM$  the Meridio-  
 “ nal Part answering to the Latitude whose Secant is  
 “  $RN$ .

12. That  $TA$  is the *Catenaria* is also demonstrable from *Dr. Gregory's* first *Prop.* Let  $Tu$  be the the Fluxion of the Ordinate  $NT$ ; and  $tu (= Nn)$  the Fluxion of the Axe  $AN$ . Then because of like Triangles  $TCM$ ,  $Tut$ ,  $CM : CT (= TA) :: Tu : ut$ , that is, as  $CM$  a constant Line to  $TA$  the Curve :: so is the Fluxion of the

Ordinate, to that of the Axe ( $y : x$ ) according to *Prop. 1. Catenaria.*

13. From the Premises the Construction and several Properties of the *Catenaria* are easily deducible; one or two of which I'll set down.

1. The Area  $ATMR$  is equal to  $AOPR$  a Rectangle contained by Radius  $AR$  and  $RP$  the Tangent answering to Secant  $HP = TM$ . For because of the like Triangles  $CMm$ ,  $CEe$ ;  $CM : CE :: Mm : Ee$ , that is, putting  $r, s, t, m$  for Radius, Secant, Tangent and Meridional part  $RM$ .)  $r : s :: m : t$  whence  $rt = sm$ , and all the  $rt =$  all the  $sm$ , that is  $AOPR = ATMR$ , which agrees with Dr. Gregory's *Cor. 5. of Prop. 7.*

14. Supposing the former Construction, let be added the Line  $RH$ , including the *Hyperbolic Sector*  $ARH$ . I say the same Sector is equal to half the Rectangle  $ARMQ$  contained by Radius  $AR$  and the Meridional Part  $RM$ , ( $= \frac{1}{2} rm$ ). For the Sector  $ARH =$  Triangle  $RNH$  wanting the Semisegment  $ANH$ . The Fluxion of the Triangle  $RNH$  is  $\frac{st + ts}{2}$ . The Fluxion of  $ANH$  is

$ts$ . So the Fluxion of the Sector  $ARH$  is  $\frac{st + ts}{2}$

$- ts = \frac{st - ts}{2}$ . 'Tis found before (*Set. 13.*) that

$r : s (s : \frac{ss}{r}) :: m : t$ ; whence  $st = \frac{ss}{r} m$ . And because

of the like Triangles  $CDE$ ,  $Efe$ ,  $CD : DE :: Ef : fe$ . But  $Ef = Mm = m$ , because both  $Ef$  and  $Mm$  are to  $Ma$  in the same Reason, *viz.* as  $s$  to  $r$ ; therefore  $r : t$

$(t : \frac{tt}{r}) :: s : m :: s : t$  whence  $ts = \frac{tt}{r} m$ , and  $\frac{st - ts}{2} =$

$\frac{s s - t t}{2 r} \dot{m} = \frac{r r}{2 r} \dot{m} = \frac{1}{2} r \dot{m}$ , = the Fluxion of the Hyperbolic Sector  $A R H$ , whose flowing Quantity is therefore equal to  $\frac{1}{2} r m = \frac{1}{2} A R M \mathcal{Q}$ .  $\mathcal{Q} E. D.$

15. This shews another Property of the *Catenaria*, viz. that it squares the Hyperbola; for  $R M$  is equal to  $N T$  the Ordinate of the *Catenaria*.

16. In *Fig. 4.* Let  $A R$  be Radius,  $A C B$  the Equitangential Curve;  $M R N$  its Asymptote, in which let  $M, N$ , be any two Points equally distant from  $R$ . Upon  $M$  draw  $M L$  parallel to  $A R$  and equal to the Difference of the Secant and Tangent of that Latitude whose Meridional Part is  $R M$  (by § 3, 4.) Upon  $N$  draw  $N O$  parallel to  $A R$ , and equal to the Sum of the forefaid Secant and Tangent. Do thus from as many Points in the Asymptote as is convenient, and a Curve drawn equably through the Points  $L - - - A - - - O$ , &c. will be a *Logarithmic Curve*, whose *Subtangent* (being constant) is equal to Radius  $A R$ .

17. Let  $n o$  be an Ordinate infinitely near and parallel to  $N O$ .  $O p = N n$  the Fluxion of the Asymptote;  $O T$  the Tangent, and  $T N$  the Subtangent to the Logarith. Curve in  $O$ . Then  $o p : p O :: O N : N T$ . But  $O N = s + t$ ; therefore  $o p = s + t$ .  $p O = m$  (the Fluxion of the Meridian or Asymptote.) So the Analogy is  $s + t : m :: s + t : N T$ . By *Señ. 13, 14*,  $s : m :: t : r$ ; also,  $t : m :: s : r$ . and thence  $s + t : m :: t + s : r$ . wherefore is  $N T$  (the Subtangent to  $L A O$ ) equal to Radius  $A R$ , a constant Line, and consequently the Curve  $L A O$  is the *Logarithmic Curve*, and its Subtangent known.

18. The same Demonstration serves for  $L M$ , (any Ordinate on the other Side of  $A R$ ) only changing the Sine  $+$  into  $-$ ; and then it agrees with Mr. James Gregory's *Prop. 3. pag. 17.* of his *Exercitationes*, viz. *That*

*the Nautical Meridian is a Scale of Logarithms of the Differences whereby the Secants of Latitude exceed their respective Tangents, Radius being Unity.* So here  $RM$  is the Logarithm of  $ML$ , the Difference of the Secant and Tangent of the Latitude whose Meridional part is  $RM$ .

19. Supposing the precedent Construction, if through any point  $C$  of the Curve  $ACB$  be drawn a right Line  $GCW$  parallel to  $MR$ , terminated with the Logarithmic Curve in  $W$  and the Radius  $AR$  in  $G$ : I say that the same right Line  $WG$  is equal to the intercepted part of the Curve Line  $AC$ .

20. Let  $mg$  be a Line infinitely near and parallel to  $WG$ , and terminated by the same Lines; and  $CS$ ,  $W\sigma$ , perpendicular to the Meridian;  $CS$  intersecting  $mg$  in  $z$ , and  $W\sigma$  in  $y$ . Let  $CM$  be a Tangent to  $AC$  in  $C$ ;  $W\tau$  a Tangent to  $AW$  in  $W$ ; so is  $CM = \sigma\tau$ . Because of like Triangles  $Cze$ ,  $CSM$ ; and  $Wyw$ ,  $W\sigma\tau$ ;  $CS : CM :: Cz : Cc$ ; also  $W\sigma : \sigma\tau :: Wy : yw$ . But  $W\sigma = CS$ ;  $\sigma\tau = CM$ ;  $Cz = Wy$ ; therefore is  $yw$  the Fluxion of  $GW$ , equal to  $Cc$  the Fluxion of the Curve  $AC$ . Consequently  $GW = AC$ . *q. e. d.*

It may be noted that this Equitangential Curve gives the Quadrature of a Figure of Tangents standing perpendicular on their Radius. In *Fig. 3.* let  $A\gamma\Gamma$  be a Curve whose Ordinates as  $g\gamma$ ,  $G\Gamma$ , are equal to the Tangents of their respective intercept Arcs  $Ak$ ,  $A\kappa$ . Let  $\Gamma G$  be produced to touch the Curve  $AC$  in  $C$ : then is the Area  $A\Gamma G$  equal to the Rectangle contained by Radius  $AR$  and  $GC$  the produced part of the Ordinate; or  $A\Gamma G = AR \times GC$ . The Demonstration of which, and of the following *Section*, I for Brevity omit.

22. If we suppose the Figure  $ACB$  &c.  $AR$  (*Fig. 3.*) infinitely continued, to be turned about its Asymptote  $RK$  as an Axe, the Solid so generated will be equal to

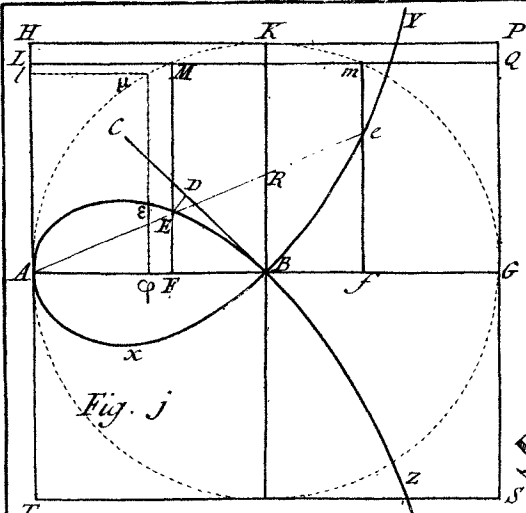
rectangled Cone whose Altitude is equal to  $AR$ . And its Curve Surface will be equal to half the Surface of a Globe whose Radius is  $AR$ . So that if the Curve be continued *both ways* infinitely (as its Nature requires) the whole Surface will be equal to that of a Globe of the same Radius  $AR$ .

The Description of the Rular and Wheel, *Fig. 2.* is sufficient for the Demonstration of the Properties of the Curve : but in order to an actual Construction for Use, I have added *Fig. 5.* where  $AB$  is a brass Rular ;  $wh$  the little Wheel, which must be made to move freely and tight upon its Axe (like a Watch-Wheel) the Axe being exactly perpendicular to the Edge of the Rular.  $s$  represents a little Screw-pin to set at several Distances for different Radii, and its under End is to slide by the Edge of the other fixt Rular.  $p$  is a Stud for convenient holding the Rular in its Motion.

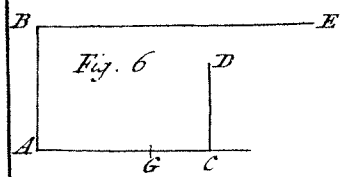
Note, *Most of these Properties of this Curve by the Name of la Traçtrice, are to be found in a Memoire of M. Bomic among those of the Royal Academy of Sciences for the Year 1712. but not publish'd till 1715. : Whereas this Paper of Mr. Perks was produced before the Royal Society in May 1714, as appears by their Journal.*

VI. *An Account of a Book entituled Methodus Incrementorum, Auctore. Brook Taylor, LL.D. & R. S. Secr. By the Author.*

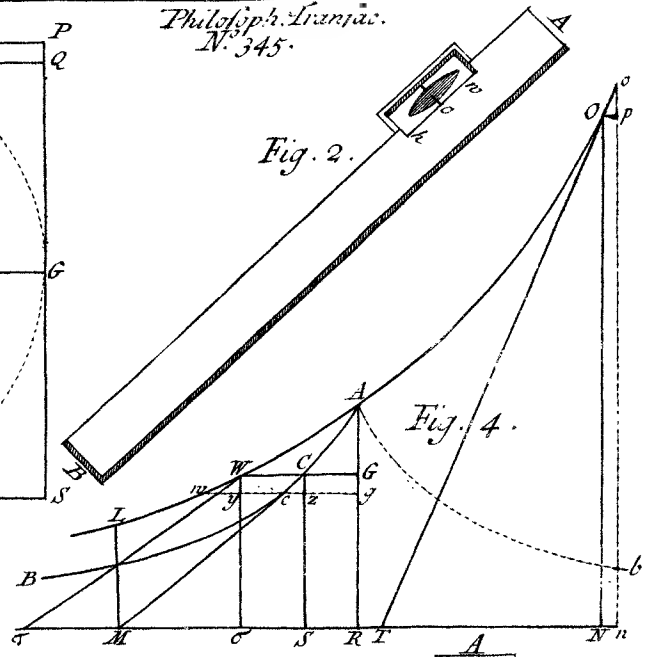
WHEN I apply'd my self to consider thoroughly the Nature of the Method of Fluxions, which has justly been the Occasion of so much Glory to its great Inventor Sir *Isaac Newton* our most worthy President, I fell by degrees into the Method of Increments, which I have endeavour'd to explain in this Treatise. For it being the Foundation of the Method of Fluxions that the Fluxions



*Fig. j.*

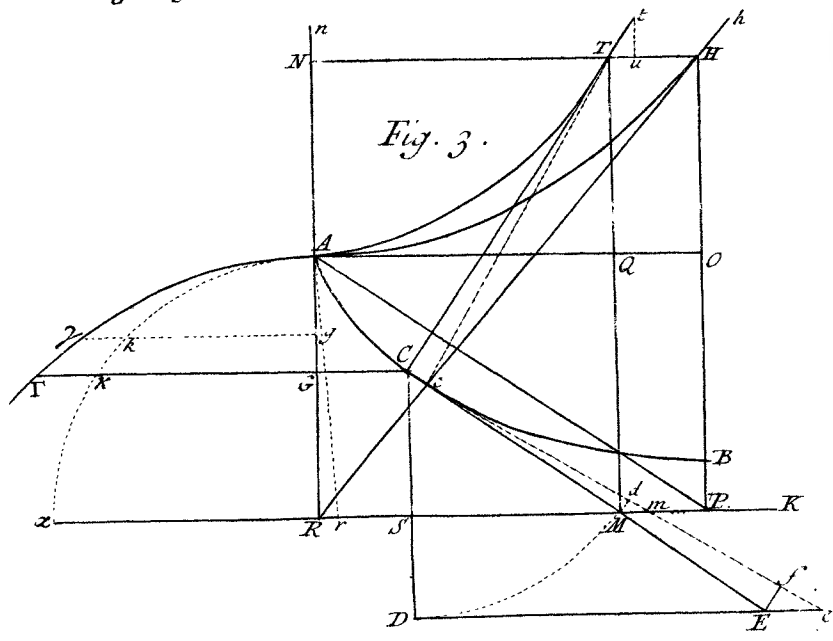


*Fig. 6.*

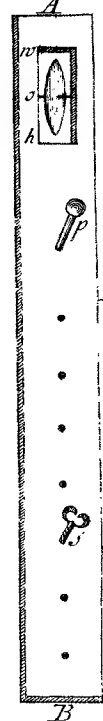


*Fig. 2.*

*Fig. 4.*



*Fig. 3.*



*Fig. 5.*

ions of Quantities are proportional to the nascent Increments of those Quantities: in order to understand that Method thoroughly, I found it necessary to consider well the Properties of Increments in general. And from those Properties I saw it would be easy to draw a perfect Knowledge of the Method of Fluxions: for if in any case the Increments are supposed to vanish and to become equal to nothing, their Proportions become immediately the same with the Proportions of the Fluxions. In this Method I consider Quantities, as formed by a continual Addition of parts of a finite Magnitude, and those parts I call the Increments of the Quantities they belong to, because that by the Addition of them the Quantities are increased. These parts being consider'd as formed in the same manner by a continual Addition of other parts; thence follows the Consideration of second Increments; and so on to third, fourth, and other Increments of a higher kind. For Example; if  $x$  stands for any Number in the Series 0. 1. 4. 10. 20. 35. &c. in which the Numbers are formed by a continual Addition of the Numbers in the Series 1. 3. 6. 10. 15. &c. then the Numbers in the latter Series are call'd the Increments of the Numbers in the foregoing Series; thus, for Example, if to the third Number (4) in the first Series, I add the corresponding third Number (6) in the second Series, I shall produce the next, that is the fourth Number (10) in the first Series, and so the rest. Any Number in the first Series being call'd  $x$ , the corresponding Number (which is its Increment) in the second Series I express by  $x$ . And these Numbers  $x$  being form'd in the same manner by the Numbers in the Series 1. 2. 3. 4. 5. &c. I call these last Numbers  $x$ , they being the first Increments of the Numbers  $x$ , and the second Increments of the Numbers  $x$ ; and so on. Hence having given any Series of Numbers that are call'd by a general Character  $x$ , their Increments are found by taking  
their



their Differences; thus in the present Example, the first Increments  $x$  in the Series 1. 3. 6. 10. 15, &c. are found by taking the Differences of the Numbers  $x$  in the Series 1. 4. 10. 20. 35, &c. and the second Increments  $x$  in the Series 1. 2. 3. 4. 5, &c. are found in the like manner, by taking the Differences of the Numbers  $x$ , and so of the third and other Increments. This Method consists of two parts; One is concerned in shewing how to find the Relations of the Increments of several variable Quantities, having given the Relations of the Quantities themselves; and the Other is concerned in finding the Relations of the Integral Quantities themselves freed from the consideration of their Increments, having given the Relations of the Increments: either simply, or they being any how compounded with their Integral Quantities. In the Method of Fluxions Quantities are not consider'd with their parts, but with the Velocities of the Motions they are supposed to be formed by; or to speak more accurately, they are consider'd with the Quantities of the Motions by which they are supposed to be generated; for the Fluxions are proportional to the Velocities, only when the moving Quantities, which produce the flowing Quantities consider'd, are equal. These Quantities of Motion, or Velocities when the moving Quantities are equal, are what Sir *Isaac Newton* calls Fluxions. As in the Method of Increments there are second, third, and other Increments; so in the Method of Fluxions there are second, third, and other Fluxions; the Fluxions themselves being consider'd as Quantities that are formed by Motion, the Quantity of which Motion is their Fluxions. As the Method of Increments consists of two Parts; one being concern'd in finding the Increments from the Integrals given, and the other in finding the Integrals having given the Increments; so does the Method of Fluxions consist of two Parts; the one shewing how to find the Fluxions, having the

the Fluents given ; and the other shewing how to find the Fluents freed from Fluxions, having given the Relations of the Fluxions, whether compounded with their Fluents or otherwise. The Principles of this Method may all be drawn directly as a Corollary from the Principles of the Method of Increments. For Sir *Isaac Newton* having demonstrated (*Phil. Nat. Princ. Math. Sect. 1.* and in the Beginning of his Treatise *De Quadratura Curvarum*) that the Fluxions of Quantities are proportional to their nascent or evanescent Increments, if in any Proposition relating to Increments, you make the Increments to vanish and to become equal to nothing, and for their Proportion put the Fluxions, you will have a Proposition that will be true in the Method of Fluxions. This is but a Corollary to Sir *Isaac Newton's* Demonstration of the Fluxions being proportional to the nascent Increments. For this reason, to make the Method of Fluxions to be understood more thoroughly, I thought it proper to treat of these two Methods together, and I have handled them promiscuously as if they were but one Method. Some people, because that the Fluxions are proportional to the nascent Increments of Quantities, have thought that by the Method of Fluxions Sir *Isaac Newton* has introduced into Mathematicks the Consideration of infinitely little Quantities; as if there were any such thing as a real Quantity infinitely little. But in this they are mistaken, for Sir *Isaac* does only consider the first or last Ratio's of Quantities, when they begin to be, or when they vanish, not after they are become something, or just before they vanish ; but in the very moment when they do so. In this case Quantities are not consider'd as infinitely little ; but they are really nothing at the time that Sir *Isaac* takes the Proportions of their Fluxions ; and the Truth of this Method is demonstrated from the Principles of the Method of Increments, in the same manner as the Ancients demonstrated

ted their Conclusions in the Method of Exhaustions, by a *Deductio ad Absurdum*.

Having premised thus much in general concerning the two Methods here treated of, to come to a particular Description of this Book; In the Preface I give a short Description of the Method of Increments, and an Account of Sir *Isaac Newton's* Notion of the Fluxions which I have already spoke of. The Book consists of two Parts, and contains 118 Pages in *Quarto*; the Propositions being number'd throughout from the Beginning. In the first Part I explain the Principles of both Methods: and in the second Part I shew the Usefulness of them in some particular Examples.

After having explain'd the Notation I make use of in the Introduction, in the first Proposition I explain the direct Method both of Increments and of Fluxions. The second Proposition shews how to transform an Equation wherein Integrals and their Increments, or wherein Fluents and their Fluxions are concern'd; so as in the Room of the Integrals or Fluents, to substitute their Compliments to a given Quantity with their Increments or their Fluxions, they increasing in a contrary Sense to the Quantities in the first Supposition. In the third Proposition I shew how to transform a fluxional Equation, so as to change the Characters of the Fluents, making that Quantity to flow uniformly which in the first Supposition flow'd unequally, having second, third and other Fluxions, and making that Quantity which in the first Supposition flow'd uniformly, now to flow unequally, so as to have second and third Fluxions, &c. This Proposition is of great use in the inverse Method, when you would invert the Expression of the Relation of the flowing Quantities; for Example, if in the Supposition  $z$  flows uniformly and  $x$  variably, by the inverse Method of Fluxions you will find  $x$  express'd by the Powers of  $z$ : but if you would find  $z$

H h h 2

express'd

express'd by the Powers of  $x$ , you must then transform the Equation by this Proposition. Sir *Isaac Newton* and Mr *de Moivre* do this by the Reversion of Serieses; but I take this to be the more proper and more genuine Method of doing it directly. In the fourth and fifth Propositions are explain'd the Method of judging of the Nature and Number of the Conditions that may accompany an Incremental or a Fluxional Equation. This is a Circumstance that I don't find to have been explain'd by any one before, and the Propositions are something intricate; wherefore it will not be improper to explain this Matter a little more at large. Suppose then that  $z$  and  $x$  are two variable Quantities, and supposing  $z$  to increase uniformly by the continual Addition of its constant Increment  $z$ , (according to the Notation I make use of in this Book) suppose  $x + z = x$ . Then if it be propos'd as a Problem to find the Value of  $x$ , express'd by the Powers of  $z$ , and quite freed from the Increments; by the fourth Proposition there may be three Conditions added to this Problem. The Demonstration of this is taken from the Formation of the Integrals by a continual Addition of their Increments. Suppose that all the Values of  $z$ ,  $x$ ,  $\dot{x}$ ,  $\ddot{x}$ ,  $\ddot{\dot{x}}$ , &c. were set down in order in so many Columns, and that at the Head of the Table, the corresponding Values of  $z$ ,  $x$ ,  $\dot{x}$ ,  $\ddot{x}$ ,  $\ddot{\dot{x}}$ , were express'd by the Symbols  $a$ ,  $c$ ,  $e$ ,  $e$ ,  $e$ . Then by means of the given Equation  $x + z = x$ , or  $\dot{x} = x - z$ , will  $e = c - a$ , whence the second corresponding Values of  $z$ ,  $x$ ,  $\dot{x}$ ,  $\ddot{x}$ ,  $\ddot{\dot{x}}$  will be  $a + z$ ,  $e + c$ ,  $e + e$ ,  $e + c - a (= e + e)$  and  $c + e - a - z$  (by the Eq.) Whence again the third Values are  $a + 2z$ ,  $e + 2e + e$ ,  $e + 2e + c - a (= e + 2e + e)$   $e + 2e - 2a + e - z$ , and  $c + 2e + e - a - 2z$ , and so you may proceed to find the fourth, fifth, and all the

the other Values of  $z, x, \dot{x}, \ddot{x}, \ddot{\dot{x}}$ . But by what is already set down, it is evident that all their Values will be express'd by  $a$  and  $x$ , and the three Symbols  $c, \dot{c}, \ddot{c}$  : and consequently all the Values of the rest of the Increments of  $x$ , viz.  $\dot{x}, \ddot{x}, \ddot{\dot{x}}, \&c.$  will be express'd by the same Symbols. Whence it follows that to determine the Values of the Symbols  $c, \dot{c}, \ddot{c}$ , there may be taken three Conditions relating to the Values of  $x, \dot{x}, \ddot{x}, \ddot{\dot{x}}, \ddot{\dot{\dot{x}}}, \&c.$  promiscuously, as the fourth Proposition directs. The same Rule holds good in the Method of Fluxions. For Example. having given the Equation  $a x^2 + x^2 \dot{x} = 0$ , if it be propos'd to describe the Curve that it belongs to; by the fourth Proposition it may also be required as a Condition, that the Curve shall pass through two given Points; that it shall touch two given Lines; that it shall pass thro' a given Point, and when it cuts a given Line shall have a given Degree of Curvature; or that it shall have any other two Circumstances that depend upon the Values of the third, fourth or other Fluxions. These Conditions that attend Incremental or Fluxional Equations, I don't know to have been sufficiently taken notice of by any Body: but they ought well to be attended to in the Inverse Methods; the Solutions of particular Problems being never perfect, unless there be provision made for the satisfying of them, by the indetermin'd Coefficients in the Equation that contains the Solution of the Problem. Examples of this may be seen in Prop. 17 and 18, where I give the Solution of the Problems concerning the *Isoperimeter*, and the *Catenaria*.

The sixth Proposition contains the general Explanation of the Inverse Method both of Fluxions and of Increments, which consists in the Solution of this Problem. Having given the Relations of the Increments, or of the Fluxions of several Quantities, whether they be considered

red with their proper Integrals or with their proper Fluents or not ; to find the Relations of the Integrals or of the Fluents, freed from their Increments or from their Fluxions. The Direction I have given for finding the Solution in finite Terms is but tentative. And I must confess I know of no other Method that is general for all Cases. For I can find no certain Rule to judge in general, whether any proposed Equation, involving Increments or involving Fluxions, can be resolved in finite Terms. For this Reason we are obliged to seek the general Solution in infinite Serieses ; which when they break off, or when they can any way be reduced to finite Terms, they then contain the Solutions which we always hope for. The Method of finding these Serieses is explain'd in the eighth Proposition, and that is by means of a Series that is demonstrated in the seventh Proposition. And this I take to be the only genuine and general Solution of the inverse Methods. For in this Solution you always have those indetermined Coefficients, which are necessary to adapt the Equation that is found to the Conditions of the Problem proposed. For want of this Circumstance all other Methods are imperfect ; and particularly *Sir Isaac Newton's* Method of finding Serieses by a Ruler and Parallelograms labours under this Difficulty, because it brings no new Coefficients into the resulting Equation, which may afterwards be determined by the Conditions of the Problem. However because this Method is very ingenious and very elegant, I thought it proper to explain it in the following (*viz.* the 9<sup>th</sup>) Prop. The 10<sup>th</sup>, 11<sup>th</sup>, and 12<sup>th</sup> Propositions conclude the first Part, and in them I treat of the manner of finding the Integral or the Fluent, having given the Expression of a particular Increment, or of a particular Fluxion of it ; without being involved with the Integrals, or with the Fluents, or with any other Increments, or with any other Fluxions of

**it.** This is a particular Case of the Inverse Method, but for its great usefulness I thought it deserved particularly to be taken notice of. This Problem is treated of in general in the 10<sup>th</sup> Proposition. The Method of solving it in finite Terms is only tentative; and when that does not succeed, recourse must necessarily be had to the Solution by a Series in the 8<sup>th</sup> Proposition. In the 11<sup>th</sup> and 12<sup>th</sup> Propositions I have shew'd how Serieses may be conveniently found, in some particular Cases when Fluxions are proposed.

In the second Part I have endeavour'd to shew the Usefulness of these Methods in the Solution of several Problems; The 13<sup>th</sup> Proposition is much the same with *Sir Isaac Newton's Methodus Differentialis*, when the Ordinates are at equal Distances: and in an Example at the End of this Proposition I have shew'd how easily *Sir Isaac Newton's* Series for expressing the Dignity of a Binomial may be found by this Incremental Method. The 14<sup>th</sup> Proposition shews in some measure how this Method may be of use in summing up of Arithmetical Serieses. In the 15<sup>th</sup> Proposition I shew by some Examples how the Proportions of the Fluxions are to be found in Geometrical Figures; from whence immediately flows the Method of finding the Radiuses of their inosculating Circles, the Invention of the Points of contrary Flexure, and the Solution of other Problems of the like nature. In the 16<sup>th</sup> Proposition I shew how the Method of Fluxions is to be applied to the Quadrature of all sorts of Curves. In the following Proposition I give a general Solution of the Problem of the *Iso-perimeter*, which has been treated of by the two famous Mathematical Brothers the *Bern ulli's*. In the 18<sup>th</sup> Proposition I give the Solution of the Problem about the *Catenaria*, not only when the Chain is of a given Thickness every where, but in general, when its Thickness alters according to any given Law. In the fol-

following Proposition I shew the *Fornix* or Arch which supports its own Weight to be the same with the *Catena-ria*. In the two next Propositions I shew how to find the Figures of pliable Surfaces which are charged with the Weight of a Fluid. In the 22<sup>d</sup> and 23<sup>d</sup> Propositions I treat of the Motion of a Musical String, and give the Solution of this Problem: To find the Number of Vibrations that a String will make in a certain time, having given its Length, its Weight, and the Weight that stretches it. This Problem I take to be entirely new, and in the Solution of it (in the last part of Prop. 23.) there is a remarkable Instance of the Usefulness of the Method of first and last Ratio's. The 24<sup>th</sup> Proposition gives the Invention of the Center of Oscillation of all Bodies; and in the 25<sup>th</sup> Proposition I have given the Investigation of the Center of Percussion. It is known that this Problem is solved by the same *Calculus* as the foregoing; wherefore it is generally thought that these two Centers are the same. But that is a Mistake, because the Center of Oscillation can be but one Point; but the Center of Percussion may be any where in a certain Line, which this Proposition shews how to find. There is an Error in this Proposition, which I was not sensible of till after the Book was publish'd, wherefore I take this Opportunity of correcting of it. It does not affect the Reasoning by which I find the Distance of the Center of Percussion from the Axis of Rotation; but it is this, that I supposed the Center of Percussion to be in the Plane passing thro' the Center of Gravity, and perpendicular to the Axis of Rotation: which is a Mistake. It is corrected by the following Proposition.

P R O P.



## P R O P.      P R O B,

*To find the Distance of the Center of Percussion from the Plane passing thro' the Center of Gravity and perpendicular to the Axis of Rotation.*

## S O L U T I O N.

Let the sixth Figure be supposed in the Plane passing thro' the Axis of Rotation, and in which the Center of Percussion is sought.

Let  $AB$  be the Axis of Rotation,  $AGC$  be the Intersection of this Figure with the Plane passing thro' the Center of Gravity, and perpendicular to the Axis of Rotation,  $G$  be the Point whereon a Line, rais'd perpendicular to this Figure, will pass thro' the Center of Gravity;  $BE$  be a Line parallel to  $AG$  wherein is the Center of Percussion. Then to find the Distance  $AB$ , let  $p$  stand for an Element of the Body proposed standing perpendicularly on any point  $D$ . Draw  $DC$  perpendicular to  $AGC$ . and  $AB$  will be equal to the Summ of all the Quantities  $p \times GC \times CD$  taken with their proper Signs, divided by the Body it self multiplied into the Distance  $AG$ .

Having thus found the Distance  $AB$ , suppose the Plane of the Figure in *Prop. 25.* to cut the present Figure at right Angles in the Line  $BE$ , and the Center of Percussion will be rightly determined by that Proposition.

The 26th Proposition shews how to determine the Density of the Air at any Distance from the Center of the Earth supposing the Density always to be proportional to the compressing Force, and that the Power of Gravitation is reciprocally as the Distances from the Center of the Earth.

The last Proposition shews how to find the Refraction of a Ray of Light in its passage thro' the Atmosphere, upon the Supposition that Light is a Body, and that the Refraction of it is caused by the Attraction of the Bodies the Rays approach to. In this Proposition there is a remarkable Instance of the Usefulness of the Method of Increments in finding the Coefficients of a Series, which according to the Values of a certain Symbol, as  $n$ , expresses both all the Fluents, and all the Fluxions of a certain Quantity.

---

## II. Ludovici Ferdinandi Marfilii *Dissertatio de Generatione Fungorum.* Rom. 1714. 4to.

THIS Author tells us that he gave his youthful Inclinations to the Study of the Mathematicks and Observations of Nature, under the Tuition of the celebrated *Malpighius*, and *Lelius Triumphettus* Botanick Professor of *Bononia*: and amongst the various Productions of Nature, his chief Delight was in the Contemplation of the sudden Growth and various sorts of *Mushrooms* which both the Earth and Trees brought forth. Of the first Kind he observed the greatest Number to arise in Camps, produced from the Horses Dung, and are commonly called *Prataioli*.

In the Years 1699 and 1700, being then in *Croatia* and *Transylvania*, in the Armies there, he made a large Volume of Designs of *Fungi*, which he sent to *Triumphetti* to put in order, who added a great Number to them of such as he found about *Bononia*; yet after all the most diligent Search, he could never find them to produce any Seed either in their Gills or other Parts.

The Origin and Generation of *Mushrooms* he says is not easy to demonstrate, since both the Antients and Moderns dis-

disagree very much about it. The late Botanists seem to be of three different Sentiments concerning their Produce. Mr. Ray, Dr. Sherrard, Mr. Doody, Boccone and Mentzelius having observed some *Mushrooms* to have had Seed, were of opinion others might have the same Original. *Clusius* and *John Baptista Porta* had in some also observed their Seed: Others, viz. *Sharrock* and the accurate *Malpighius*, who could not find any Seed in them, altho' with the Assistance of Microscopes, did suppose they might be produced by Pieces of themselves, carried by the Winds from place to place, as other Plants are by slips and Offsets.

The third Opinion, which he says most agree in, is that they arise from Putrefaction, or a Mixture of certain Salts, Sulphur and Earth impregnated with the Dung of Beasts.

The *Fungus seminifer Campaniformis Mentzelii*, &c. being the Mushroom which first gave the occasion of the Opinion of their having Seed, this nice Author has accurately figured and observed, and supposes with others that these seedlike Bodies may be the *Ovaria* of some Insects; and the rather because they are so very large in proportion to the smallness of the *Mushroom*: and that they had often been sowed by Dr. *Amadoes* a curious Botanist, without any Success towards raising them. From whence he concludes these Bodies ought to have another Denomination than Seed; neither is he of the Opinion that they are produced by parts of themselves.

In his Division of *Mushrooms* he first treats of the *Truffles* and their Increase, Situation and Soyl, Colour, Taste and Consistence. He next proceeds to soft Mushrooms, such as he observed in his own Garden; which having in the Spring been meliorated with Horse-dung, about the middle of *June* there sprung up divers of that sort which the *Italians* call *Pratainoli*, amongst a Bed of *Lettice*. These continued till near the midst of *August* before they went

off. Of these and some other Kinds he accurately figures the first Shootings and Fibres.

His next Tribe are such as grow from Wood, but yet are themselves soft. Of these he observes three Kinds; the first a large one in his Window, out of a piece of Firwood which it had often rained on; with two smaller sorts from some rotten Boards in his Garden. All these he figures both in their natural and divided States, as also Microscopically

Treating of hard woody *Mushrooms* (of which he also gives you some accurate Figures) he observes they rarely appear on the Trees, in *Germany* and *Croatia*, before they are twenty or thirty Years old; but most commonly when forty or fifty: and the Original of them he attributes chiefly to the Rottenness of the Wood, and says they generally break out in the Spring, when the Leaves begin to shoot. And that usually they grow below the middle of the Trees, and are cause of so much Decay in them, that they often die in three or four Years.

It may not here be amiss to subjoin what Dr. *Lancisus* communicates to our Author, concerning the *Lapis Fungarius*, viz. that altho' this *Mushroom-producer* has the Name of a Stone, it ought not to be reckoned of that *Genus*, it being really no other than a Mass or *Congeries* of Roots, Seeds and Juices coagulated with Earth into, as it were, a stony Substance. Upon which pouring Water and setting it in a warm Place, it loosens its hardened Substance; and by mollifying its Fibres and moistning its concrete Juices, out of the Cliffs and Chinks thereof the *Mushrooms* spring, as they do in other places from simple Dung and loose Earth. And it is also farther to be noted, that when this stony Mass has thus yielded these its Offspring, the Remains grows light, porous and decay'd, its nutritive Juices being then exhausted.

# PHILOSOPHICAL TRANSACTIONS.

For the Months of November and December, 1715.

## The CONTENTS.

- I. *A short History of the several New-Stars that have appear'd within these 150 Years: with an Account of the Return of that in Collo Cygni, and of its Continuance observed this Year 1715.*
- II. *BOTANICUM Hortense IV. Continued from No. 345. By James Petiver, F. R. S.*
- III. *An Extract of a Letter from Dr. Helvetius at Paris, to Monsieur Duyvenvoorde Ambassador Extraordinary from the States-General, and by him communicated to the Royal-Society.*
- IV. *A Letter of Mr. Francis Neville to the Right Reverend St. George, Lord Bishop of Clogher, R. S. S. Giving an Account of some large Teeth lately dug up in the North of Ireland, and by his Lordship communicated to the Royal-Society*
- V. *Remarks upon the aforesaid Letter and Teeth, by Thomas Molyneux, M. D. and R. S. S. Physician to the State in Ireland: Address'd to his Grace the Lord Archbishop of Dublin.*
- VI. *Guilhelmi Musgrave Reg Societ. utriusque Socii, GETA BRITANNICUS. Accedit Domus Severianæ Synopsis Chronologica: & de Iconicula quondam M Regis Ælfredi Dissertatio. Ilcæ Dumnoniorum. MDCCXV. I i i I.*

I. *A short History of the several New-Stars that have appear'd within these 150 Years ; with an Account of the Return of that in Collo Cygni, and of its Continuance observed this Year 1715.*

Whether it be owing to the greater Diligence of the Moderns, or that in reality no such thing has happen'd for many Ages past, I will not undertake to determine ; but this is certain that, within the Space of the last 150 Years, more Discoveries have been made of Changes among the Fixt Starrs, than in all Antiquity before. And tho' it be said that *Hipparchus*, on occasion of a New Star that appeared in his Time, was induced to number the Stars, and make the first Catalogue of them, which was, in the Opinion of *Pliny*, *Res vel Deo improba* ; yet neither he or any of the Ancients have left us the Place of that New Star, to compare with those lately seen, one of which might perhaps be the same with it, re-appearing after a long Period of Years. Now though several Authors have severally described those that have been seen nearer to our Times, it may not perhaps be amiss here to give a short Recapitulation of what was principally remarkable in each of them, with the Times of their first Appearance, as far as can be collected.

And first, That in the *Chair of Cassiopeia*, was not seen by *Cornelius Gemma* on the Eighth of *November 1572*, who says, he that Night considered that Part of Heaven in a very serene Sky, and saw it not : but that the next Night, *Novemb. 9<sup>o</sup>*. it appeared with a Splendour surpassing all the fixt Stars and scarce less bright than *Venus*. This was not seen by *Tycho Brahe* before the 11th of the same Month, but from thence He assures us that it gradually decreased and died away, so as in *March*

1574, after sixteen Months, to be no longer visible; and at this Day no Signs of it remain. The Place thereof in the Sphere of Fixt-Stars, by the accurate Observations of the same *Tycho*, was  $9^{\circ}. 17'. 21''$   $\alpha$   $1^{\text{ma}}$   $\star$   $\gamma^{\text{is}}$ , with  $53^{\circ}. 45'$ . North Latitude.

Such another Star was seen and observed by the Scholars of *Kepler*, to begin to appear on *Sept. 30<sup>th</sup>. ft. vet. anno 1604*, which was not to be seen the Day before: but it broke out at once with a Lustre surpassing that of *Jupiter*; and like the former it died away gradually, and in much about the same time disappear'd totally, there remaining no Footsteps thereof in *January 1608*. This was near the Ecliptick, following the Right-Leg of *Serpentarius*; and by the Observations of *Kepler* and others, was in  $7^{\circ}. 20'. 00''$   $\alpha$   $1^{\text{ma}}$   $\star$   $\gamma$ , with North Latitude  $1^{\circ}. 56'$ . These two seem to be of a distinct *Species* from the rest, and nothing like them has appear'd since.

But between them, *viz.* in the Year 1596, we have the first Account of the wonderful Star in *Collo Ceti*, seen by *David Fabricius* on the third of *August*, *ft. vet.* as bright as a Star of the third Magnitude, which has been since found to appear and disappear periodically: its Period being precisely enough 7 Revolutions in Six Years, tho' it return not always with the same Lustre. Nor is it ever totally extinguish'd, but may at all times be seen with a Six-Foot Tube. This was singular in its Kind, till that in *Collo Cygni* was discovered. It precedes the first Star of *Aries*  $1^{\circ}. 40'$ , with  $15^{\circ}. 57'$  South Latitude.

Another New Star was first observed by *Will. Janssonius* in the Year 1600, in *Pectore* or rather in *educatione Colli Cygni*, which exceeded not the third Magnitude. This having continued some Years, became at length so small as to be thought by some to disappear entirely: but in the Years 1657, 58 and 59, it again arose to the third Magnitude, tho' soon after it decay'd by degrees to the

fifth or sixth Magnitude, and at this Day is to be seen as such in  $9^{\circ}.18'.38'$ . à  $1^{\text{ma}}$   $\star$ .  $\gamma$ , with  $55^{\circ}.29'$ . North Lat.

A fifth New Star was first seen and observed by *Hevelius* in the Year 1670, on *July 15. st. vet.* as a Star of the third Magnitude, but by the Beginning of *October* was scarce to be perceived by the naked Eye. In *April* following it was again as bright as before, or rather greater than of the third Magnitude, yet wholly disappeared about the middle of *August*. The next Year, in *March* 1672. it was seen again, but not exceeding the sixth Magnitude: since when it has been no further visible, though we have frequently sought for its Return; its place is  $9^{\circ}.3^{\circ}.17'$ . à  $1^{\text{ma}}$   $\star$ .  $\gamma$ . and has Lat. North.  $47^{\circ}.28'$ .

The Sixth and last is that we described from the *Acta Berolinensia*, in No. 343 of these Transactions; discovered by Mr. G. Kirch in the Year 1686, and its Period determined to be of  $404 \frac{1}{2}$  Days: and though it rarely exceed the fifth Magnitude, yet is it very regular in its Returns, as we found in the year 1714. Since then we have watched, as the Absence of the Moon and the Clearness of Weather would permit, to catch the first beginning of its Appearance in a Six-Foot Tube, that bearing a very great Aperture discovers most minute Stars. And on *June 15.* last, it was first perceived like one of the very least Telescopical Stars; but in the rest of that Month and *July* it gradually encreased, so as to become in *August* visible to the naked Eye; and so it continued all the Month of *September*. After that it again died away by degrees, and on the *8th* of *December* at Night was scarce discernible by the Tube, and as near as could be guessed, equal to what it was at its first Appearance on *June 15th*: so that this Year it has been seen in all near Six Months, which is but little less than half its Period: And the middle, and consequently the greatest Brightness, falls about the *10th* of *September*. Those that please to seek for it. may expect its first Appearance in *July* next, and find it in  $9^{\circ}.6^{\circ}.30'$ . circiter à  $1^{\text{ma}}$   $\star$ .  $\gamma$ , with Lat. Bor.  $52^{\circ}.40'$ . 11.



## BOTANICUM Hortense IV.

II. Continued from No. 345. By James Petiver,  
F. R. S.

## SECT. II.

## Indian Herbs and Trees.

94. **A**ntego Green Blite.  
*Blitum Antegoanum viride*, caule & pediculis  
*rubris*.

This rises about a *Yard* high, its *Leaves* smooth, veined and oval, standing on long slender *Pedicles*, red, as are the large *Stalks*, from whence grow Tufts of green *Panicles*, which *Flower* and *Seed* from *July* till *Autumn*.

I received *Plants* and *Seed* of this and many others from my worthy Friend Mr. *John Douglass* Surgeon, and Brother to his Excellency the Governour of *Antego*.

95. Climbing *Virginia* Eupatorium.

*Eupatorium Carolin. scandens*, *Fegopyri folio* Hort. nost.  
*Sicc. Ray* Vol. 3. *Append.* 244. E. 30.

*Clematitis* novum genus, *Cucumerinis foliis Virginianum*  
*Pluk. Tab.* 163. fig. 3.

*Planta peculiaris pappescens non lactescens Banister* Alm.  
*Botan.* p. 109 pl. 6.

This elegant *Plant* is accurately *Figured* in Dr. *Pluknet's* *Phytographia*, and Mr. *Banister's* *Herbarium Virginianum* which is now in the *Press* from his own *Original Designs*. It is the only *Virginia Climber* of this *Tribe* that has as yet come to our Knowledge, and never raised in any *European Garden* before.

96. *Braynes Cape Naked Daffie*, Ray H. Pl. 362. pl. 2. &  
Vol. 3. p. 220 pl. inter 6 & 7.

*Coma Capensis Coronopi folio.*

*Bellis Afric. lutea minor*, fl. nudo cernuo *Alm* Bot. 66.  
pl. 6.

*Bellis Afric. Coronopi folio*, fl. nudo *Ciaffi*.

*Bellis Afric. capitulo aphylo luteo*, *Coronopi folio*, cauliculis procumbentibus *Herm. H. Leyd.* 86.

*Bellis annua*, capitulo aphylo luteo *H. Ox. Sect. 6. Tab. 7.*  
fig. ult. opt.

*Chrysanthemum Afric. minimum*, flosculo nudo cernuo  
*Ejusd. p. 30. pl. 24.*

*Chrysanthemum exoticum minus*, capitulo aphylo, *Chamemeli nudi facie Breyn. Cent. 156. c. 76. fig.*

*Chrysanthemum Tingitanum minimum* procumbens, foliis versus imum dentatis, flosculo nudo cernuo *Moris.*

Its *Leaves*, naked *Flowers*, and Way of growing distinguish it from others.

97. Trifid Cape Gold Tufts, Ray 3. p. 173. 1.

*Coma aurea Africana* foliis glaucis in extremitate trindis  
*Hort. Amstelod. Vol. 2.*

It *Flowers* in September, and the Seed is ripe about Christmas.

98. Small Headed American Live ever.

*Elichrysum Carolin. Gnaphalii Americani facie Hort. nost.*

*Sicci Ray 3. Append. 244*

*Helichrysum annuum majus, erectum Virginianum H. Ox.*

*Sect. 7. Tab. x Ser. 2. pl. 1.*

*Helichrysum* five *Chrysocome* Gnaphaloides *Virginiana* annua, foliis obrusioribus, capitulis argenteis conglobatis

*Bot. Oxon. 88. pl. 21.*

*Gnaphalium Lufit. comis argenteis Pluk. Tab. 31. fig. 5.*  
ex sent. *J. Eobart.*

This rises near a *Yard* high, is somewhat *Woody* with many Branches ending in *Tufts* of small straw coloured *Heads* which rarely or never fully open. The *Indians* rub their *Head* with this Plant, and assert its good for the *Eye-sight*, as my late curious Friend *Mr. John Lanson* informed me. By another Person I am told they drink a *Tea* of it in *Fevers*.

99. *Fairchild's* small-flowered *Live-ever*.

*Elichrysum* fl. pallenscibus minimis, *Spice* foliis.

Its *Stalks* are thick set, with whitish pointed *Leaves*; the *Flowers* grow in *Tufts* of a pale *Yellow* and very small. It *Flowered* in *July*, &c. in *Mr. Thomas Fairchild's* Garden at *Hoxton*, the only Place I have yet seen it in.

100. *Woolly Live-ever* with red thready *Flowers*.

*Elichrysum* *Lychnidis Coronariae* folio.

This elegant *Plant* and the next, I have with *Pleasure* seen in the *Bishop* of *London's* Gardens at *Fulham*, under the *Care* of *Mr. Millward*.

101. *Round Saddle-leaved Cape Live-ever*.

*Elichrysum* *Capense*, *Perfoliata* folio.

These *Leaves* are round, somewhat bristle-edged, grow alternate and saddle the *Stalk*, like our *Perfoliata* or *Thorow Wax*. My late industrious Friend *Mr. William Brown*, Surgeon, brought me from the *Cape of Good Hope* the only *Specimens* of this singular *Plant* I have since seen.

102. *Wetted Antego Spike-Cudweed*.

*Gnaphaloides* *Antegoana* spicata, caule alato.

an *Amaranthoides* fruticosum fol. longis angustis, subtus nivei. *Jam. Cat* 48. pl. 3. *Hist.* p. 43. *Tab.* 7. f. *Ray Vol.* 3. p. 127. 2.

This elegant *Plant* was raised in *Chelsey-Garden* from *Seed* sent me by my kind Friend *Mr. John Douglass* at *Antego*.

103. Herman's *Cape* Live-ever with *Sage* Leaves Ray 1860  
Hist. Ox. Bob. 905.

*Pseudo-Elichrysum* Cap. *Salvia* folio.

*Conyza Afric.* arborefc. *Salicis Caprea* foliis, odore *Rorismarini* Breyn. Pr. 2.

*Conyza Afric.* incana arb odore *Salvia* & *Rorismarini* Flor.  
Pruff 149.

*Elichryso* affinis *Afric* arb fl purp. violaceis, *Salvia* foliis,  
odore *Rorismarini* Herm. H. Leyd. 229. fig. Pluk. 174. 1.

It Flowers in *March* and *April* in our *Stoms*, and at the  
same time at the *Cape of Good Hope*.

104. Herman's *Peruvian* Live-ever Ray 1869. pl. ult.

*Elichryso* affinis *Peruviana* frutescens Herm. H. Leyd. 666.  
Pluk. 27. fig. 1.

*Agerato* affinis *Peruviana* frutescens Par. Bat. & Prodr.

*Pseudo-Helichrysum* frut. *Peruv.* fol. longis ferratis Bob. Ox.  
90. 3.

This by some has been erroneously shewn in our *Gardens* for the true *Cortex Peru*.

105. Mary-land *Bobart.* Ray 3. p. 210. pl. 15.

*Bobartia lutea* hirsuta, caule Echii.

*Chrysanthemum Helenii* folio, umbone floris grandiusculo  
prominente Pluk. 242. fig. 2. Bob. Ox 23. pl. 65.

*Chrysanthemum pilosissimum* umbone purpurascente, petalis  
extus villosis Nob. Act Phil. No. 246. p. 401. pl. 26.

Its lower *Leaves* somewhat like *Plantain*, lightly notchd,  
rough and hairy, the *Stalks* speckled with red, and rough  
as *Pipers Bugloss*, its *Flowers* composed of 13 yellow *Peta-*  
*le* set in a double Row of narrow green hairy pointed  
*Leaves*. What is remarkable in this *Tribe*, is a large purple  
*Umbo* or *Disk*, rising in the midst of the *Flower* like a  
*Button*. A very peculiar sort, of this *Family*, I first saw  
many Years since with Mr. *Jacob Bobart* in the *Physick-Gar-*  
*den* at *Oxford*; for which reason I have presumed to di-  
stin-

stinguish it by his Name, that it may be the easier known from *Chrysanthemum*, *Dracunculus* or *Ptarmica* to which others have ranked it. This *Flowers* most part of the *Tear*.

106. *Fairchild's broad Bobart.*

*Bobartia Virginiana*, fol. lato scabro, basi alato.

Its Flower-stalk swells gradually towards the Head, which is composed of many regular broad pointed blackish green *Scales*, the Rim consists of 15 or more yellow *Petals*, out of its purple Disk come many small yellow *Flosculi*, which I have not observed in the other. Mr. *Thomas Fairchild* raised this Plant from Seed he received, with many others, from that curious Botanist Mr. *Mark Catesby* of *Virginia*. It Flowered at *Hoxton* about the middle of *October*.

107. Cape *Uvedale* with a *Poplar Leaf*, Ray 339. 1.

*Uvedalia Capensis Populi folio.*

*Chrysanthemum arborescens Æthiopicum*, foliis *Populi* albæ  
Breyer. Cent. 155. c. 76. fig. Bob. Oxon. 23. pl. 58.  
Sect. 6. Tab. 3. Ser. 3. fig.

an *Chrysanthemum lanatum*, crenatis foliis *Æthiopicum* Pluk.  
Tab. 274 f 5.

This differs from the *Chrysanthemums* in having a lacciferous Rim.

108. Wild *Hopps*. Ray 3. p. 307. 16.

*Nodiflora Jamaic. Scrophularia folio.*

*Sideritis spicata Scrophulariæ folio*, fl. albo, spicis brevibus  
habitoribus rotundis, pediculis insidentibus *Stoan*.  
Cat. Jam. 65. Hist. Tab. 109. fig. 2.

That curious Naturalist Dr. *Hans Sloane* has well described this Plant, and given a very accurate *Figure* of it, which truly agrees with a fair Specimen my hearty Friend Capt. *Thomas Walduck* sent me from *Barbadoes*, from the Seed of which this Plant was raised. I take the *Nodiflora*

L. L.

Luzon. *Sideritidis* folio *Gazoph. Naturæ Tab.* 69. fig. 6. to be a sort of this with narrower Leaves.

109. Herman's *Virginia* yellow Basil.

*Clinopodium Virgin.* angustifol. fl. luteo *Herm. H. Leyd.* 161.

*Clinopodium* angustifol. *Virg. Lamii* fl. luteo maculato *Bob. H. Oxon.* 375. 8. *Seet* xi. Tab. 2. Ser. 2. fig. 2.

*Clinopodium Virgin.* angustifol. flor. amplis luteis, punctis purpureis *Pluk. Tab.* 24. fig. 1.

*Origanum* flor. amplis luteis purpureo maculatis, cujus caulis sub quovis verticillo 10 vel 12 foliis est circumcinctus *Banist. Ray* 1927.

I have seen this in *Flower* with Mr. *Fairchild*, raised from *Seed* which Mr. *Catesby* sent him.

110. Canary *Clary*. *Ray* 3. p. 291. 5.

*Horminum* hastatis amplioribus foliis f. *Ari* modo alatis, caulibus & pediculis araneosâ lanugine villosis ex *Insulâ Gomera Pluk. Tab.* 301. fig. 2.

*Mustazi Insularis* & *Salvia arborea* vulgò *Alm. Bot.* 185. pl. 5.

*Horminum Canariense* tomentosum hastato folio, *Mustazi* & *Salvia arborea* nominata *Bob. Oxon.* 394. 17. *Ray* 3. p. 292. pl. 24.

*Sclarea* folio triangulari caule tomentoso *Inst. Rei Herb.* 180.

This *Flowers* in divers of our *curious Gardens* from *June* till *Autumn*.

111. White Canary Horehound. *Ray* 3. p. 302. pl. xi. & 12. *Stachys Canariensis* frutesc. *Verbasci* folio *Instit.* 186.

*Stachys* amplissimis *Verbasci* foliis, floribus albis parvis non galeatis, spicâ *Betonicæ* ex *Insula Canarina Pluk. Tab.* 322. fig. 4. *Alm. Bot.* 356.

*Stachys Canarica* frutescens *Salviæ* folio, fl. candido, *Arvida Salva* incolis nominata *Bob. Oxon.* 382. pl. 6.

*Stachys*

*Stachys Canariensis* frutescens, *Verbasci* foliis Hort. Amst. Vol. 2:

*Salvia* sylv. amplissimis *Verbasci* foliis graveolens, fl. albo parvo *Canariensis* Aim. Bot. 329. pl. 15. Ray 274. pl. xi. It holds its Leaves all the Winter in our Stoves.

112. Munting's yellow Maracoc. R. 651. 8.

*Clematis* f. *Flos Passionis* fl. luteo H. Pisan. 18.

*Clematis Passionalis* triphyllus fl. luteo Ox. Mor. 7. 3. Tab 2. Ser. 1. f. 3.

*Clematis Passiflora* fl. luteo Munt. Prax. 422. fig. opt.

*Cucumis Flos Passionis* dictus, *Hederaceo* folio, fl. ex luteo viridanti, Herm. H. Leyd. 205.

*Clematitis* f. *Flos Passionis Americana* luteo flore Vallot. 53.

an *Clematitis Indica* fl. minimo pallido Plum. 73. Tab. 88.

*Balsamina altera Indica* repens, *Hedera* arboreæ foliis, fl. subviridi Ambros phyt. 91.

*Granadilla* folio tricuspidi, fl. parvo flavescente El. Bot. 206. Inst. 240.

*Granadilla* folio *Hederaceo*, fl. luteo minore Flor. Norib. 200.

*Granadilla pumila*, fl. parvo luteo D. Alex. Balam. H. Patav. à Turre 55.

*Flos Passionis* minor, folio in 3 lacinias non ferratas minus profundas diviso Cas. Jam. 104.

*Passiflora Hepaticæ Nobilis* folio parvo non crenato, fl. ex luteo viridante Alm. Bot. 282. 1.

This Plant is a Native of *Virginia* from whence Mr. Catesby has lately sent it.

113. The Old Trefoil Maracoc Ray 649. 1.

*Balsamina Indica* repens, Pomifera Honuphr. 5.

*Clematis Passiflora*, fl. Roseo triphylla Munt. Prax. 423. f.

*Clematis Passionalis* triphyllus, fl. Roseo Mr. Ox. 7. 2. Tab. 1. fig. 9.

*Clematis trifolia*, fl. Roseo clavato C B. 301. xi.

*Cucumis triphyllus* fl. Roseo clavato Herm. Leyd. 205.

*Granadilla Hispanis*, Flos Passionis Italica Col. in Herm.  
887. & 90. fig. opt.

*Granadilla triphylla*, fl. Roseo clavato Fl. Nor. 199.

*Maracoc* five *Clematis Virginiana* Park. Gard. 393. 10. fig.  
395. 7.

*Maracot Indicum Aldini* Hort. Farnes. 50.

*Passiflora foliis crenatis tripartito divisis* Alm. Bot. 281.  
pl. 3.

This beautiful Old Plant has been an Ornament in our  
English Gardens for near a Hundred Years, and was first  
brought to us from *Virginia*.

114. Common Fingered Maracoc.

*Clematis Passiflora pentaphylla*, fl. cæruleo punctato Munt.  
421. fig.

*Clematis pentaphylla*, fl. Roseo clavato Mor. Ox. 6. 8.  
Tab. 1. fig. 8.

*Clematis quinquefolia Americana* f. Flos Passionis Roberti  
Icon.

*Cucumis Flos Passionis dictus*, pentaphyllos, fl. clavato  
Herm. H. Leyd. 205.

an *Flos Passionis major pentaphyllos* Cat. Jam. 104. pl. 1.

This elegant Climber is found in divers Gardens of the  
Curious, but I could never yet observe the Fiddle-like Dent,  
in the middle Leaf, as Munting, Morison, &c. have Fi-  
gured it.

115. Ever-green Fingered Maracoc.

*Passiflora pentaphylla sempervirens*.

This chiefly differs in being ever-green. I have obser-  
ved it both in Flower and Fruit, in Mr. Thomas Fairchild's  
Garden at Hoxton.

116. Yellow Thorney Poppey Ray 856. 8.

*Argemone Mexicana* El. Bot. 204. Inst. 239.

Papa-



*Papaver spinosum* C B. 171. 17. prodr. 92. fig. phyt. 311  
15. C B. Matth. 748. f. 2. I. B. 3. l. 30. p. 397. fig. Clus.  
93. fig. 1. Imperat. 662. fig. 2. Jonst. 371. f. 4.

*Papaver campestre spinosum* Chabr. 459. x. Ic.

*Papaver spinosum Americanum* Park. 366. f. 5. opt.

*Papaver spinosum luteum, foliis albis venis notatis* Moris.  
Ox. 277.

*Papaver spinosum, fl. luteo simplici* Munt. p. c. 555.

*Carduus Chrysanthemus Peruanus* Ger. 993. f. 2. Jonst.  
1155. 2.

*Chicallotl Mexic. seu Spina* Hernand. 215. c. 60. fig.

*Ficus Infernalis Italonum an Glaucium* Diofc Ray 856. 8.

*The Purging Thistle, i. e. Carduus Purgans nostratibus dicta*  
Alm. Bot. 279. pl. 8.

This singular Plant is a Native of both the *East* and  
*West* Indies.

It *Flowers* and *Seeds* in our Gardens in *July, August, &c.*  
117. Hairy Oriental Poppy.

*Papaver Oriental. hirsutissimum, fl. magno* T. Coral. 17 *Co-*  
*mel.* Plant. rar. 34. fig.

My hearty and very worthy Friend Mr. George London  
was the first who shew'd me this in *Flower*; since which I  
have observ'd it in our *Physick Garden* at *Chelsey*.

118. Spanish Potatoes Ray 728. 22.

*Batata Hispanor. Camotes s. Amores & Ignanes* Lob. Ic.  
647. *Obs.* 369. f.

*Batatas Clus. Exot.* 341. & *Inhame Lusitan. Hist.* 78. fig.

*Batatas Occid. India & Inhame Orient. Lusit. Park.* 1383.  
f. 3.

*Battades, Ignames* Adv. 317. fig. radicum.

*Convolvulus Indicus Batatas dictus* Ray H. Pl. 728. pl. 22.

*Convolvulus Ind. Orient. Inhame seu Batatas* Mor. Ox xi.  
4. *Tab.* 3. fig. 4.

*Convolvulus Ind. Or. tuberosa eduli, cortice rubro & al-*  
*bo Battatas dictus* Par. Bat. prodr. 326.

*Convolvulus rad. tuberosa* esculenti, *Spinachia* folio, fl. albo fundo purpureo, semine post singulos Flores singulo Jam. Cat 53. Hist. 150.

I have gathered this in the Dutchess of Beaufort's Garden at Chelsea.

119 White *Virginia* Bindweed, with a blackish bottomed Flower.

*Convolvulus Virg.* fol. cordato, fl. albo minore, fundo nigricante.

an *Convolvulus Scamoni* folio subrotundo, fl. albo, umbone nigro *Curassaviens* Herm. Par. Bat Cat. 6.

Its Leaves cordated, small and very pointed, the Flowers also small, slender and white, but blackish at the Bottom. We owe the Discovery of this to the inquisitive Mr. Catesby.

120 Broad-leaved Cape Goat-Cranesbill.

*Geranium Tragodes* Capense, folio maximo.

an *Geranium Africanum* frutescens, *Malva* folio laciniato, odorato instar *Melissæ*, fl. purpurascens *Boerhaave* 6 p. 110.

Its Flowers are generally composed out of two small flesh coloured Petals, with a Blot of deep scarlet in the Middle, and a Streak of white running from thence down to the Bottom. I first observed this with the Bishop of London at Fulham, and since in our Physick Garden at Chelsea. It Flowers in April and May.

121 Cape Codling-Cranesbill with bright Flowers.

*Geranium Capense* frutesc. folio rotundo, Pomaceo odore, fl. vivido.

an *Geranium Afric.* arboresc. fol. *Malvæ* plano, lucido, glabro, fl. kermesino D. van Leur. Boer. 3. p. 109.

I have only seen this at the Bishop of London's Garden at Fulham; it differs from *Botan. Hortense* No. 2. pl. 103. in having a much livelier red Flower.

122. Small Smooth curl-leaved Cape Cranesbill,  
*Geranium Capense folio Betonica crispo, fl. minimo.*

Its lower *Leaves* are smooth and more or less round and broad, the upper *Leaves* are deep cut, with two or three small purple *Flowers* standing on very fine slender *Footstalks*.

123. Dr. *Uvedale's* Spot-Flowred Cape Cranesbill R. 3. p. 510. pl. 2.

*Geranium Capense fol. Betonica molli, fl. maculato.*

*Geranium African. Betonica folio procumbens, fl. parvis eleganter variegatis Alm. Bot. 169.*

Dr. *Pluknet*, that copious Botanist, first observed this in Dr. *Uvedale's* curious Garden at *Enfield*. It's *Stalks* and *Leaves* are soft and hoary, the *Flowers* small and deeply spotted like the *Lychnis hirta minor*.

124. Spotted American *Arum*, with whitish Veins.

*Arum Amer. majus maculatum, venis eleganter albis.*

I have seen this beautiful *Arum* in Flower in the *Bishop* of *London's* curious Gardens at *Fulham*.

125. Small *Virginia* Trefoil *Arum*.

*Arum humile Virgin. triphyllum.*

an *Arum Zeylan trilobato folio, humilius & minus Par. Bat. 79. fig.*

Mr. *Thomas Fairchild* gave me the only Specimen of this which I saw growing in his Garden at *Floxtan*.

126. Great-Smooth Cape Sumac. Ray Dendr. 58. 12.

*Sumach Capensis fol. rotundo splendido majore.*

*Rhus Afric. trifoliatum majus, splendente folio rotundo integro Ray Dendr. 58. 12.*

This and the next I have seen in the *Dutchess* of *Beaufort's* Gardens at *Badminton*.

127. Small Smooth Cape Sumac. R. Dendr. 58. xi.

*Sumach Capens. fol. rotundo splendido minore.*

*Lentiscus humilis, trifolia Africana P. Bat. pr.*

*Rhus Afric. trifoliatum minus glabrum, splendente folio subrotundo integro Pluk. Tab. 129. fig. 9. & Ray Dendr. 58. xi*

This chiefly differs from the last in being less, particularly in its *Leaves*.

128. Hairy dented Cape Sumac. *R. Dendr. 56. 1.*

Sumach. *Cap. folio dentato hirsuto.*

*Rhus seu Sumach Afric. trifoliatum hirsutum & crenatum Herm. Ray Dendr. 56. 1.*

*Rhus Afric. trifol. majus, fol. obtusis & incis is hirsutis pubescentibus Pluk. 129. f. 7. & Ray Dendr. 56. 1.*

These *Leaves* are deeply dented and hairy, by which its known from the rest.

129. Narrow white Cape Sumac. *R. Dendr. 57. 8.*

Sumach *Cap. fol. angusto subtus incano, hinc inde dentato.*

*Rhus Afric. trifoliatum fol. serratis Herm. R. Dendr. 57. 8.*

*Rhus Afric. trifol. majus, fol. subtus argenteis acutis & margine incis is Pluk. Tab. 129. fig. 6. & Ray Dendr. 5. p. 57. 8.*

*Rhus Afric. trifoliatum, folio Agni Casti Herm. Boerhave 257. & 8.*

*Rhus Afric. trifol. angustissimo folio subtus incano, seu Agni Casti lobis Herm. R. Dendr. 56. 2.*

This differs from the next in having narrow *Leaves* somewhat jagged.

130. Round white Cape Sumac *Ray Dendr. 58. 13. & 14.*

Sumach *Cap. folio subrotundo integro subtus incano.*

*Rhus Afric. trifol. majus, fol. subrotundo integro molli & incano Pluk. T. 219. fig. 8. & Ray Dendr. 58. 14.*

*Rhus Afric. trifol. fol. brevioribus nervosis superne glabris & splendentibus, subtus incanis Ray Dendr. 58. 13.*

All these *Trifoliate Sumachs* grow spontaneously about the fertile Cape of good Hope, and from thence brought into the Gardens of the most Curious, where I have seen them both in England and Holland.

III. *An Extract of a Letter from Dr. Helvetius at Paris, to Monsieur Duyvenvoorde Ambassador Extraordinary from the States-General, and by him communicated to the Royal-Society.*

**I** Am extreamly pleased, Sir, that you have applied your self to me, for my Advice about the Use of the *Pareira Brava* which has been recommended to you, because I can give you a very good Account of it, having been one of the first that introduced it in *France*; I have made abundance of lucky Experiments about it, which have made this Medicine very well known to me: wherefore I assure you, you can do nothing better than to make tryal of it.

The *Pareira Brava* is a Root which comes to us from *Brazil* by the way of *Lisbon*, but which the War has rendered pretty scarce; however it is to be found among the good Druggists, and is sold at *Paris* for 40 *Livres* the Pound: 'tis call'd in *Brazil* the Universal Medicine, and is made use of there in all kind of Distempers. A Capuchin Monk, who came from thence, told me that he could not give it a greater Character than by assuring me, that in all their Voyages they carryed the Gospel in one Pocket and the *Pareira Brava* in the other.

'Twill be very easy to convince you, Sir, that the *Pareira Brava* is perfectly good in your Distemper. The Business with you is to restore the Digestions, to the end, that in the first Passages there may not be form'd so much Phlegm and acid Crudities; and it is also necessary to hinder the Serosity of the Blood from spreading it self too much upon the Parts. Now as Experience shows us  
that

that the *Pareira Brava* does abundantly provoke Urine, it will follow from thence that it will discharge by the Kidneys the corrosive Acidity of the Mass of Blood ; it is a so good to break and thin the puerous and viscous Humors ; and it cures the Suppressions of Urine occasion'd by Obstructions in the Kidneys.

One may conclude from hence, that the Salts of the *Pareira Brava*, which are moderately Volatile, are proper to dissolve or separate the too thick and too close Texture of the Sulphur of the Lympha Finally this Medicine has a light or gentle Bitterness which corrects the Acids of the Stomach, and renders them more pure and fine.

Hence the Chyle becomes better digested and more Balsamick, and fitted to assimilate it self with the Blood, and to preserve therein that degree of Division and Fluidity which is necessary for it.

The Method of using this Root with success, is to reduce it to an impalpable Powder, and to infuse thereof the weight of a Demi-gros in a Pint of boiling Water, and let it lye in it all Night, and next Morning boyl it one moment. Then pour the Liquor off gently from the Powder, and take of it a Demi-setier in two Cups with a little Sugar as hot as Tea, putting into each Cup 5 Grains of the said Root reduced to an impalpable Powder, which you must stir with a Spoon, that none of it may remain at the Bottom. You may repeat the same Dose about 4 Hours after Dinner, but you must not eat any thing within an Hour after you have taken it.

This Medicine does not oblige you to alter the ordinary Course of your living ; and you may continue the use of it several Months together, in which time also you may discontinue it two or three Days together at a time, if you please ; but you should take some gentle Purge every Fortnight or Three Weeks during the use of the said Medicine.

*the Preparation of the Pareira Brava, as Monsieu  
Duyvenvoorde uses it.*

**T**AKE Eleven Grains of this Root, and put it into a Pewter Tea-pot fill'd with boyling Water, and so let it infuse all Night over warm Ashes, or a very small fire; and in the Morning boyl it again, but very gently, till you use it. You must drink it just as you do Tea, and the Liquor which comes from this Infusion must not exceed the Quantity of 5 small Dishes of Tea.

---

*IV. A Letter of Mr. Francis Nevile to the Right Reverend St. George Lord Bishop of Clogher, R. S. S. Giving an Account of some large Teeth lately dugg up in the North of Ireland, and by his Lordship communicated to the Royal-Society.*

*Belturbet, July the 29th. 1715.*

My LORD,

**T**HE Curiosity I here send your Lordship, is so far beyond any thing that I have had the honour to communicate to your Lordship, or that I have ever met with, that I presume your Lordship will think it fit to communicate to the Royal-Society; I have sent the Draught, after the best manner I could draw it, enclosed; it is the Draught of two Teeth lately found within Eight Miles of this Town at a place call'd *Maghery*, in part of the Bishop of *Killmore's* Lands, sinking the Foundation for a Mill near the Side of a small Brook that parts the Countys of *Cavan* and *Monaghan*.

The

There are in all four Teeth, two of a larger and two of a smaller sort, the largest is the farthest Tooth in the under Jaw, the other is like it and belongs to the opposite Side; the lesser Tooth I take to be the third or fourth Tooth from it, and has its Fellow: these are all that were found, and one of them in a Piece of the Jawbone, which fell to dirt as soon as taken out of the Earth; there was part of the Scull found also of a very large Size and Thickness, but as soon as exposed to the Air that mouldered away as the Jaw had done.

The Account I had led me last Week to the Place, where I was resolved to make the nicest Search I could; but the Water-wall of the Mill being built, and the Ground all incumbered with the Earth that was thrown up, I could have little Opportunity of doing any thing, but to enquire of the Workmen the manner of finding the Teeth, and where and how they lay. There were some few Peices of Bones found, but none entire, yet by those Bits that were found, one might guess that they were Parts of those that were of a larger Size.

The Place where this Monster lay was thus prepared, which makes me believe it had been buried, or that it had lain there since the Deluge. It was about four Foot under Ground, with a little Rising above the Superficies of the Earth, which was a Plain under the Foot of a Hill, and about 30 Yards from the Brook or thereabout. The Bed whereon it lay had been laid with fern, with that sort of Rushes here call'd *Sprits*, and with Bushes intermixed. Under this was a stiff blew Clay on which the Teeth and Bones were found: Above this was first a Mixture of yellow Clay and Sand much of the same Colour; under that a fine white sandy Clay which was next to the Bedd: the Bedd was for the most part a Foot thick, and in some Places thicker, with a Moisture clear through it; it lay sad and close and cut much like Turfe, and  
would



would divide into Flakes, thicker or thinner as you would ; and in every Layer the Seed of the Rushes was as fresh as if new pull'd, so that it was in the Height of Seed-time that those Bones were lay'd there. The Branches of the Fern, in every Lay as we open'd them, were very distinguishable, as were the Seeds of the Rushes and the Tops of Boughs. The whole Matter smelt very fower as it was dug, and tracing it I found it 34 Foot long, and about 20 or 22 Foot broad.

It will be well worth consideration what sort of a Creature this might be, whether Human or Animal ; if Human, there was some reason for the Interrment, and for that Preparation of the Bed it was laid on ; if Animal, it was not worth the Trouble : if Human, it must be larger than any Giant we read of ; if Animal, it could be no other than an Elephant, and we do not find that those Creatures were ever the Product of this Climate. And considering how long this must have lain here, I do not believe the Inhabitants then had any Curiosity or Conveniency to bring such into this Kingdom ; for I suppose the best of their Ships could not carry one. Then if an Elephant, or some other Beast which must have proportion to the Teeth, it must have lain there ever since the Flood ; and if so, then the Bed on which it lay must be of its own making : whence it will follow that the Flood coming on him while he lay in his Den, he was there drown'd, and covered with Slime or Mud, which since is turn'd into the Substance of the Earth before-mention'd. I forgot to mention that there was a great many Nutshells found about the Bed, perhaps those might have been on the Bushes which composed part of the Bed.

The two large Teeth are of equal Weight, two Pound three Quarters each ; the two little Teeth are six Ounces  
M m each ;

each; but there are some of them wasted, and some of Holders that go into the Jaw broken off.

I am,

My LORD,

Your Lordship's most dutiful  
and obedient Servant.

FRANCIS NEVILE.

---

V. *Remarks upon the aforesaid Letter and Teeth, by Thomas Molyneux, M. D. and R.S.S. Physician to the State in Ireland: Address'd to his Grace the Lord Archbishop of Dublin.*

MY LORD,

WHEN your *Grace* was pleas'd to communicate to me a Letter you received some while since, containing an Account of an extraordinary Natural Curiosity, lately discover'd in the *North of Ireland*, in the County of *Cavan*, you desired I would give you my Thoughts concerning it, and the Purport of the Letter: but truly when first your *Grace* gave me the Opportunity of perusing this Account, and I consider'd the imperfect Sketches of the *Teeth* annex'd to it, I was not a little concern'd, that upon the making so surprizing a Discovery, I could not command a Sight of the Originals themselves, from whence the Draughts were taken; or that so great a Curiosity should be express'd by the Hand of an Artist that shew'd so little Skill: however, by the best Judgment

I could make from so imperfect an Information, I told your *Grace* then, I was pretty well convinced they must have been the *Grinding Teeth* of an *Elephant* : Yet I engaged, if hereafter I might be so lucky as to procure a View of the *Teeth* themselves, I would be more positive in my Opinion, and give the Reasons on which I grounded my Conjecture ; as likewise I would have the Shape of the *Teeth* express'd in their full Dimensions, by more true and exact Figures.

Since that, the *four Teeth*, with some of the Fragments of the Bones that were found with them, have been brought here to *Dublin*, where, by the Favour and Assistance of my ingenious Friend Sir *Thomas Southwell*, I procured the Loan of them, so long as to examine them particularly, make some Remarks, and take the following correct Sketches, that express their Form truly, just as big as the Life ; and your Lordship seem'd well satisfied with the Performance of the Artist, when at the same time I produced the Draughts and the Originals from whence they were copied, that we might compare them both together.

Upon the whole, I am now fully convinced, and I can upon sure Grounds affirm to your Lordship, that they must certainly have been the *Four Grinding Teeth* in the lower Jaw of an *Elephant* : and that the many loose Fragments of those large Bones that were found with them, must have been Remains of the same *Animal*. This I take to be one of the greatest Rarities that has been yet discovered in this Country.

In order to clear this Matter 'twill be first requisite to have recourse to, and explain the annex'd Figures

Figure the 1<sup>st</sup>. *AA* is the large Grinder of the under Jaw on the right Side, weighing two Pounds and three Quarters of a Pound.

M m m 2

b.

*b. b. b. b. b. b.* are white, rough, indented Borders, Seven in Number, of an irregular Shape, rising about the tenth of an Inch higher than the hard black shining Surface of the Tooth ; this rough raised Work serves for the bruising and grinding the *Animal's* Food, the rough Grains of Rize, Leaves, Fruits and the Boughs of Trees ; and is made of so extream an hard Texture, that it resembles large knotted Threads of white *Glass*, laid on and closely fastned to the dark Superficies of the *Tooth* : and answers that glassy Surface wherewith Nature has armed the Outside of the *Teeth* of most *Animals*, to prevent their wearing from the constant Attrition in Chewing of their Foods.

*c. c. c. c. c.* is that part of the Tooth which rises above the Gumms, and continues even now distinguish'd from the rest of the Bone, by having its Colour of a different Shade.

*d. d. d. d. d. d.* are many strong Tangs or Roots, seemingly united altogether, by which the Tooth received its Sense and Nourishment, and tho' it was so large and ponderous. by these it kept firmly fixt into the Jaw.

For the Mechanism Nature shews it self to have followed in framing the *Teeth* of this *Animal*, is no more than this : whereas in other Creatures, she has divided that bony Substance wherewith they chew their Food, each having its peculiar *Roots* to secure its Articulation in the Jawbone : she has in this of so great Bulk (As *Pliny* the *Naturalist* styles it *Terrestrium maximum Elephas*.) for the greater Strength, Stabiliment, and Duration of it's *Teeth*, and the better to provide for a compleat Attrition of the Aliment, in order to perfect the Digestion so thoroughly, as to sustain the Life of the Animal for two or three hundred Years, (as it is a common received Opinion in the *East*) She has, I say, contrived to make the Substance of the *Teeth* in their Roots below, and in their upper

per parts above the Gums, closely unite together; and coalescing thus, form a few large massy Teeth instead of many small ones.

As for instance, in *Man's Body*, that is of so much a less Size, the Number of the Teeth, (when the whole Set is compleat) reckons to thirty two, whereas in the large *Elephant*, the Teeth of both the Jaws amount in all but to Eight, besides it's two great Tusks, which rather serve as Horns for its defence than Teeth to prepare it's Food, and therefore I think not so very properly call'd Teeth.

Figure the 2<sup>d</sup>. *E. E.* is the smaller *Grinding Tooth* of the under Jaw on the same side: it's Surface covered over with the same white indented Work, as before describ'd for grinding of the Food.

*f. f. f.* are three large Roots that kept it firmly fixt in the Jaw Bone.

This smaller Tooth weighed full six Ounces.

Figure the 3<sup>d</sup>. *G. G.* is the large *Grinder* of the under Jaw on the left side, much of the Size and Shape and Weight with it's fellow Tooth describ'd Figure the 1<sup>st</sup>. It shews its Roots and all its parts, with the rough protuberant white Work on its upper Surface made after the same Contrivance, and formed after the same strong Model as the former.

And truly if one considers it, 'tis plain that were not the *Teeth* of this Creature made of so large a Size, and withal of so massy and firm a Substance, 'twere absolutely impossible they could resist the Force, and bear all that Pressure wherewith those vast Muscles exert themselves, that move the lower Jaw in Mastication in this so strong an Animal.

Figure the 4<sup>th</sup>. *H. H.* is the smaller *Grinding Tooth* of the under Jaw on the same side; it is less compleat than the small Tooth describ'd before in Figure 2<sup>d</sup> for some of the Root is wanting, and part of its outward grinding Surface

Surface is broke off at *k. k.* so that it weighs somewhat less ; yet what remains exactly shews the same kind of Work and Shape of the other Tooth, that answer'd it on the right Side.

These *Four Teeth* here describ'd, fully compleat the Set of the Teeth, wherewith Nature has furnished the lower Jaw of the *Elephant* ; and are answered by just as many more, formed after the same manner in the upper Jaw, as Dr. *Moulins* informs us, who dissected the *Elephant* that was burnt here at *Dublin* in 1681. In it's Anatomy p. 40. speaking of the Teeth he assures, there were besides the Tusks only four Teeth in each Jaw, two in every side : and that these eight Teeth were all *Molares*, so that he had no *Incisores*.

But notwithstanding this, perhaps it will be said, we may not hastily conclude from hence, that our *Great Teeth* dug up in *Ireland* must certainly have been the *Four Grinders* of an *Elephant*, since they might as well belong to some other large kind of *Terrestrial* or *Marine Animal*. As for the Hint of their being *human* or *gigantick*, 'tis so groundless a Thought, and so contradictory to *comparative Anatomy* and all *Natural History*, it does not deserve our Consideration.

To obviate this, I shall take notice first in general, that the differing Kinds of living Creatures, wherewith Nature has stock'd the World, are not more distinguish'd by the Make of any part of their Bodies from one another than by the various Shape and Disposition of their *Teeth* : and hence it is, we shall not find any two distinct *Classes* of *Animals* that do exactly agree in the same Make and Ranging of their Teeth.

But yet to be more particular, and make this Point so plain, I hope, as that it may admit of no Controversy, I shall here set down at length, as I find them. the  
Words

Words of two late Authors, that purposely have described the *Teeth* of the *Elephant*.

The first I shall mention is Mr. *Patrick Blair*, who has publish'd a Treatise he calls *Osteographia Elephantina*, or a Description of the Bones and other Parts of an *Elephant*, that died and was dissected near *Dundee* in *Scotland*, anno 1706. in the *London Philosophical Transactions* for April, May, June, July, August and September, 1710. Numb. 3. 6. and 327. Here giving us a Description of the Teeth of this *Animal* pag. 110. he says, *Dr. Moulins* well observes that they are all *Molares*, being two Inches broad in that part of them wherewith they grind, and six Inches and a half long on the Right Side, and five Inches and a half on the Left: Their Surface, tho' flat, is yet very unequal, for they have alternately placed, running from the Right to the Left Side, an *Hollowness* and then an *Eminence*; and this *Eminence* is surrounded by a rough protuberant Border. There are Nine of these *Hollownesses* and as many *Eminences*, undulated as they paint *Sea Waves*,

'Tis remarkable how very exactly all this agrees with our Figures; 'tis true those *Hollownesses* and *Eminences* which he mentions to be *Nine*, do not so nicely hit with the Number of those in our *Teeth*: but this Difference proceeds from hence, that he describes here the Grinders of the upper, whereas ours are the *Teeth* of the lower Jaw; tho' such a Distinction as this, I am apt to think, may very well arise even in those of the same Jaw, in various Animals, from some peculiar Disposition in one from another, nay and perhaps in the same Animal, at differing times, according as it happens to be older or younger, but this by the bye.

A little farther pag. 114. and 115. where he gives an Account of those of the under Jaw, he says.

*The hind Tooth of the Right Side is four Inches, and that on the Left five: the one half of their Surface, where they begin*

gin to appear above the Gums, is semicircular, with the fore-mentioned Ridges and Sulci running transversely, four on the Right Side and five on the Left, the other half (or Tooth I suppose he means) has five of these Eminences where it grinds on the Right, and four on the Left: each of the four Teeth is six Inches long, and has six or seven of the forementioned Eminences and as many Depressions: these Teeth are the most firm, solid and weighty Bones of any Animal yet known.

So much from Mr. Blair.

The other Author I shall produce for the further Illustration of this Matter, is the laborious and accurate Naturalist Mr. Ray, who, in his *Synopsis Animalium Quadrupedum*, when he comes to give us the Description of the Elephant, has the following Words. *Os pro mole Bellua parvum, quatuor in utràque maxillâ Dentibus molaribus seu Dentium molarium Massis instructum; si quidem plurimi Dentes in Os solidum & durum ita infixi sunt, ut cum eo & inter se unum & continuum Corpus efficiant. Dentes hi lineas parallelas undulatas octo vel novem in superficie massæ efficiunt; suntque reliquo osse candidiores: Massæ integræ, Dentium singularium modo, per Gomphosin maxillis inseruntur. Incisoribus omnino caret.*

Thus Mr. Ray in very proper and expressive Terms describes the Teeth of this Animal: and truly if your Grace will but compare Mr. Blair's Words with his, and the Particulars of both Accounts with the Description and Figures we have before given of the Teeth dug up in Ireland, and observe how they all agree exactly, even so as one may say they tally together, I think it will amount to nothing less than Demonstration, and that all our Ideas have been taken from one and the same Natural Object; and as they, so we, must certainly have described no other Teeth but those of the Elephant.

But then perhaps it will be ask'd what is become of all the rest of the Teeth that were in the upper Jaw, which  
being



being as firm and solid Bones as those that are here preserved, might for the same reason have still remained intire.

But since we find it otherwise, 'tis obvious to imagine a probable Conjecture how this might come about. From what Mr. *Nevil* mentions in his Letter, 'tis plain that the Bed where all these Bones were found, must once have been the outward Surface of the *Earth*, the *Green-Sod*, producing *Rushes*, *Fern* and *Nutts* : and when the heavy Beast first fell dead upon this Spot, the Scull, with all the Bones and Teeth of the upper Jaw, being the highest Parts of the *Animal*, might likely fall in such a Posture, as to be exposed some while above the *Earth* ; tho' those of the under Jaw first coming to the Ground, might make themselves a Bed, and being covered with the Mould remain preserv'd, whilst the upper Teeth, and most of the other Bones, lying exposed to the Injuries of the Air and Weather, before they got a Covering, might rot and quickly moulder all away.

But tho' this be allowed, yet still a greater Difficulty remains unsolv'd ; how this large Body'd *Animal*, a *Native* of the remote warm *Climates* of the *World*, should be deposited in this wild *Northern Island*, (where *Greeks* or *Romans* never had a footing) so many Miles from Sea, and distant from those Places of the Isle where People might most probably resort.

And still to make the Difficulty yet greater, we must consider, not only from the dark black Colour of the Teeth, contracted by their lying long under Ground, and the remarkable Alteration wrought on their bony Substance, which (by the mineral Streams and Exhalations it has imbib'd whilst it was in the Earth) is now become more solid, hard, and ponderous, than it was naturally at first, (nay in some Parts we find it plainly petrified) but also from the perishing of all the other Bones of the *Animal's Body*, and from the considerable *Depth* of

*Earth* that covered those that were found : we must conclude, I say, from hence, that they have lain in this Place for many Centuries : I won't say with Mr. *Newil* ever since the *Flood*, because I can't suppose that the slight Texture of vegetable Substances, *Nutts* and the Seeds of *Rushes*, could possibly have been preserv'd so long : But this, at least, may safely be affirmed, that these Remains must be Cotemporaries with some of the remote Ages of the *World* ; which carries us so far back into the earliest Times, that we can ne'er imagine the rude Inhabitants of *Ireland*, or any of their neighbouring Countries, were Masters of so much Art, in those Days of Ignorance and Darknes, as to make Carriages by Sea strong and capable or of Curiosity and Politeness enough, to transport a Beast of this large Size from those far distant Countries where 'twas bred ; which they that now attempt do find a Work of vast Care, Trouble and Expence, even in this Age wherein *Navigation* is brought to such perfection.

These Considerations, my Lord, grounded on other Instances of the like kind, make me inclined to think this *Elephant* we are speaking of, might not be brought hither by any Care or Industry of *Man* : but the Surface of this Terraqueous Globe might, in the earliest Ages of the *World*, after the *Deluge*, but before all Records of our oldest *Histories*, differ widely from its present *Geography*, as to the Distribution of the *Ocean* and *Dry-land*, its *Islands*, *Continents* and *Shores*, so as to allow this Beast, and others of its Kind, for ought I know, that may by some such Accident hereafter be luckily discoverd, a free and open Passage into this Country from the Continent.

For otherwise, how can we explain that that other vast large stately *Animal* the *Moose-Deer*, little inferior to the *Elephant* it self, could have been brought to *Ireland*, (where elsewhere I have shewn it formerly was common) from distant *North America*, even long before that Quar-  
ter

ter of the World was known, and is the only Region I can hear, where this great Beast is found at present.

And can we well imagine that *Foxes*, *Otters*, *Badgers*, *Tigers*, *Wolves*, with *Linxes* and such ravenous *Animals* as we have been told, have lately been discovered by the great Snows that fell this present Winter in the *Island of Sardinia* and other Places, should ever be imported (being useless noxious Beasts of Prey) by the Industry of *Man*, to propagate in *Islands*, that they might destroy *Men's Food* and Flocks, and make their Lives not only uneasy but unsafe?

Nay how can we suppose that *Birds* of shortest Flight, the various Sorts of poisonous *Serpents*, and of offensive *Creeping Vermin*, with all the various Tribes of smaller *Insects*, could possibly be found in *Islands*, unless they had been stock'd with those Inhabitants when the Intercourse between them and the Continent was free and open.

But in whatever manner this *Elephant* (to return to our Subject) might first have made its way for *Ireland*; this is beyond dispute, that the *Bones* of *Elephants* have been discovered deep under Ground, in other Places as well as this Kingdom: and those too out of the way, far distant from the Native Countries of this Animal.

For not many Years ago, in a Hill near *Erfurt*, a Town of the *Upper Saxony* in *Germany*, several Parts of the *Skeleton* of an *Elephant* were Dug up: on which Occasion *Wilhelmus Ernestus Tentzelius* Historiographer to the Duke of *Saxony*, writ a Letter to the very learned *Antonio Magliabechi*, Library Keeper to the great Duke of *Florence*: This Treatise is published, but I have not been so lucky as to procure a Sight of it, and know no more but just the Title-page *Wilhelmi Ernesti Tentzelii Historiographi Ducalis Saxonie Epistola, de Sceleto Elephantino Tonnæ nuper effosso, ad Antonium Magliabechium, Magni Ducis Etruriae Bibliothecarium.*

And I am well persuaded, by the best Construction I can make of those imperfect and obscure Accounts, we have in *Evert Isbrand Idde's* curious Travels from *Muscovy* to *China* over Land; Chap. the 6th, (which he confesses he only gathered from the barbarous *Osttacks* Inhabitants of that Country) concerning the vast *Teeth* and *Bones* and *Limbs* of *Mammuths*—as he calls them, frequently found (and diligently sought after to make profit of them) in the Hills, and Banks of several Rivers in *Siberia*, the *Keta*, *Jenize*, *Trugan*, *Montgamsea* and *Lena*; that they are nothing else but the Remains and *Skeletons* of *Elephants* buried there, and accidentally discovered by the *Earth's* opening, and falling down on the sudden Thaws, after severe long Frosts. But of this, please to consult the Author, whose Words are too prolix to be inserted here.

But to bring this Matter still nearer home to our selves, Mr. *Cambden* in his *Britannia* is of opinion, that those great monstrous *Teeth* and *Bones*, which he takes notice to have been at several times dug up in many parts of *Great Britain*, must have been the Remains of *Elephants*; but then he thinks, they must be of those that *Dion Cassius* the Historian tells us, the *Roman Emperor Claudius* brought over, when he made his Expedition into that *Island*. But that this truly is so, I own is but Surmise as yet, and has not been so fairly proved by him or any other, as that we can rely upon't with satisfaction.

What Mr. *William Somner* the learned Antiquary has published in his Discourse of *Chartham News* is more remarkable; (this is reprinted lately in the *Philosophical Transactions* for July 1701. No. 272.) where he informs us, that in the Year 1668 in the Village of *Chartham* near *Canterbury* in *England*, digging within 12 Rods of a River, they found a Parcel of strange monstrous *Bones*, some whole, some broken, together with four *Teeth* perfect and sound, each weighing something above half a Pound, and some of them almost

most as big as a Man's Fist. They are all Cheek-Teeth or Grinders; the Earth in which they lay being like a Sea Earth, or Fulling Earth with not a Stone in it.

'Tis observable how this Account in many of it's Circumstances, agrees with that of Mr *Nevil* in his Letter to your Grace: as that the Teeth were all Grinders, Four in number, found with other large broken Bones near a Brook, and in a Claiey Earth, without a Stone: but then the weight and Magnitude of our largest *Teeth* so far surpass those that were found in *England*, that these did not come up to a fifth Part of those, which shows they could not be the Teeth of the same Animal: I must confess the Author does not so much as suspect they were *Elephant's Teeth*, but on the contrary is of opinion that they belong'd to another Species, the *Hippopotamus* or *River-Horse*, a Beast that's yet a greater Stranger in these Parts of the World, than the *Elephant* itself; and therefore it's Passage hither can never be accounted for; but by some such like Supposition as we have made.

However Mr. *John Luffkins* in his Letter, wherein he designs to have reference to that Discourse; and which is inserted in the *Philosophical Transactions* for Sept. 1701. No. 274. differs in his Judgments from Mr. *Somners* about these Teeth, which he thinks must have been *Elephant's Teeth*; as he is positive those large Bones he describes in the same Letter, and found near *Harwich* in *Essex*, certainly must have been.

Not having seen, much less examined, any of the Bones or Teeth concern'd in this Controversy; either those that were found in *Kent*, or those in *Essex*; I cannot well take upon me to determine any thing in this matter; tho' those dug up at *Chartham*, as I understand, may still be perused by the Curious among the Natural Rarities of the *Royal Society* in their Repository at *London*. But this at present I can safely say, that if the *Figures* of the *Teeth*  
given.

given us by Mr. Somner, and represented in the Plate of the foremention'd *Transaction* No. 272. be genuine and well exprest (as I have no reason to doubt, as coming from one so skilful and so accurate) they no way seem to agree either in Shape or Make, or in that particular and *Characteristick* Work on the grinding Superficies, with the *Teeth* of the *Elephant*; or with the Description and Figures we have given, which I am sure are both correct and natural.

I should now, my Lord, make some Apology for detaining your *Grace* so long upon what may seem so light and trivial a Subject, a Piece of meer Curiosity: but I am so vain as to hope, whatever others may fancy, it may not appear so inconsiderable altogether to your Lordship's more discerning Judgment.

For I am inclined to think, (even from these Imperfect Hints) that if we had more correct Histories and Observations of this kind, made in distant Countries, and skilfully registered, with all their instructive Circumstances, they might lead us into great and momentous *Truths* relating to the *Deluge*; to the wise Methods of Providence, in replenishing all Regions of the *World* with *Animal Beings* soon after the *Flood*; and to the Knowledge of several important Changes that may have happen'd on the Surface of this our *Terraqueous Globe*: Inquiries that are truly worthy the utmost Application of the most learned *Divine* and the most sagacious *Philosopher*.

But I shall stop here, and only beg leave to subscribe my self, with the utmost Respect,

My L O R D,

Your Graces most devoted  
faithful and humble Servant.

T. MOLYNEUX.  
This

*This Letter of Mr. Nevile with Dr. Molineux's curious Draughts of the Teeth, and his learned Remarks upon them, having been produced and read before the Royal Society, they ordered that what Teeth they had of like sort should be look'd out and laid before them; to which Sir Hans Sloane was pleas'd to furnish a yet greater Variety, out of his incomparable Collection of Natural Rarities. And to obviate all Doubts, there being at this time in Westminster the entire Skull of a large Elephant with the Teeth in it, That was likewise ordered to be viewed and compared with the Figures: which done, it appeared that the Teeth in question could be no other than those of an Elephant.*

*By this Enquiry we were likewise satisfied, that the Number of Teeth found, being but four, was no Objection: it appearing that the Number of Molares in this Animal is not certain. Pliny Lib. XI. Cap. 37. says expressly Dentes Elephantis intus ad mandendum quatuor, præter eos qui prominent. And in the Remains of that mighty Elephant described by Tenzelius. Phil. Trans. No. 236. there were no more than four Teeth found. In that at Westminster there are Six, viz. One in each lower Jaw, and Two in each of the Upper, whereof the inner Tooth is about three times as long as the other, and both together longer than those of the under Jaw by about an Inch; the upper small Teeth being much worn by grinding. These we have thought fit to represent by Fig. 5. shewing the rough grinding Surface of the left under Tooth, being considerably Concave; and by Fig. 6. the same Roughness on the upper Teeth is shewn, having a Convexity tallying with the Concavity of the under, which is a Circumstance not observed by any of those that have described them.*

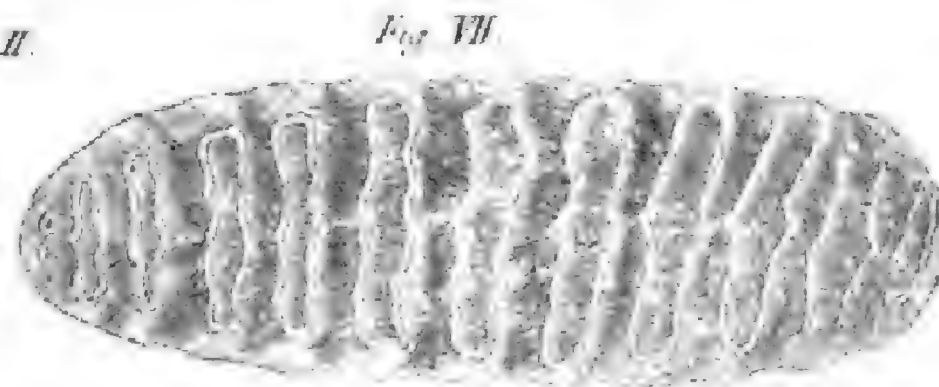
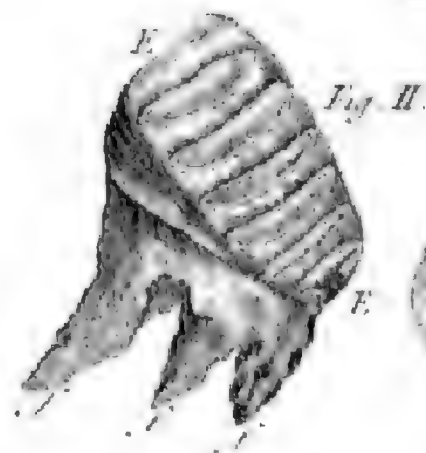
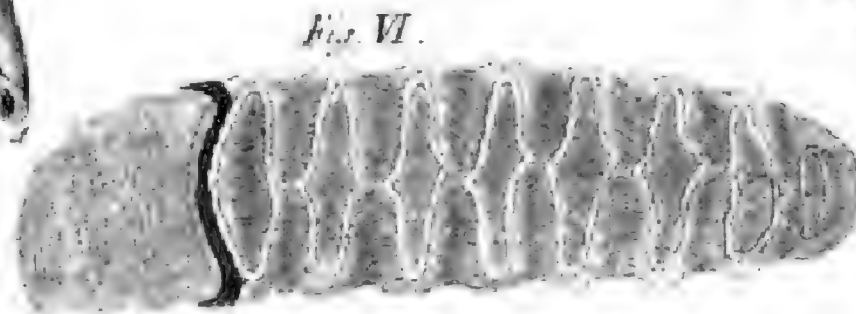
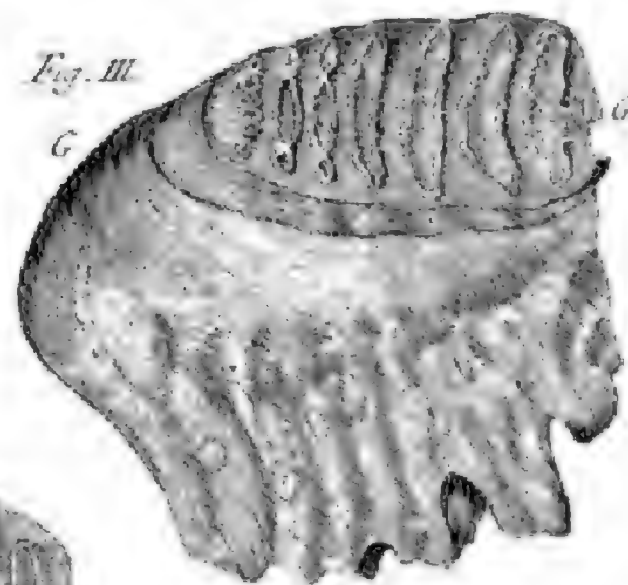
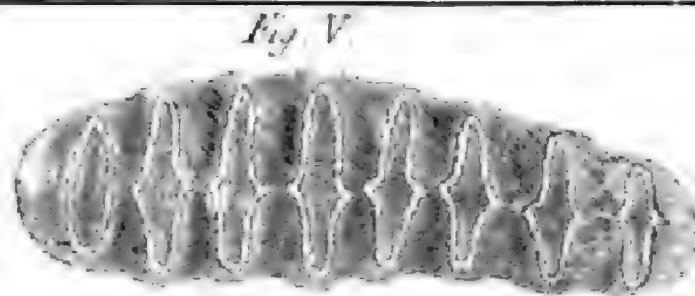
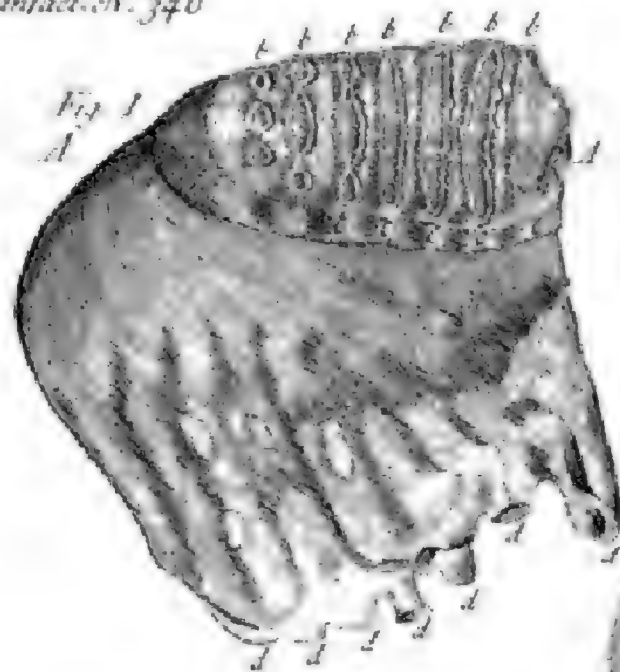
*And altho, by the Observation of Mr. Du Verney, Dr. Moulins, and Mr. Blaire, who dissected three different Elephants, it appear that each of them had eight Molares: yet from them it is also evident that in the division of them Nature observes no Rule, For Dr. Moulins found the two Teeth in each of the upper Jaws of that he dissected, to be divided*

ded after a different manner ; so that the inner Tooth on the one side, and the outer on the other, was bigger than its adjoining Fellow, yet not so as to be very unequal : and Mr. Du Verney and Mr. Blaire had on both sides the much greater Tooth outwards : whereas the Westminster-Skull, on the contrary, has only a small one outwards, and the much greater Grinder within. All which considered, we may with Assurance conclude, that this Elephant found in Ireland had but four Teeth in his Head when he died ; and that the two Greater were those of the upper Jaws, and the other two those of the Under.

Again, by the Size of the grinding Part, we may conclude these to be the Teeth of a very young and small Elephant ; since they are not much above half the Length of those that are to be seen at Westminster, which belonged to a Beast of not more than between 10 and 11 Foot high ; nor much above one Third of the Length of a fossile Elephant's Grinder in the Royal Society's Repository, the which is here represented by Fig. 7. (all the Figures being drawn to the Scale of half their true Dimensions). Hence it is not to be marvelled that the Bones of so young an Animal, having not acquired their Firmity, as being in a growing State, should be dissolved by long lying in the Earth, as also the Roots of the Teeth.

On this Occasion, perhaps it may not be amiss to quote a Passage out of Mathew Paris his History, who assures us, that in his Time Louis IX. (afterwards St. Louis) King of France, made a Present of an Elephant to his Cotemporary Henry III. of England ; and that in the Year 1255, after the English had been fourscore Years Masters of Ireland. Of this says Mathew, *Nec credimus quod unquam aliquis Elephas visus est in Anglia præter illum.*





VI. *An Account of a BOOK.* Guilhelmi Mufgrave Reg. Societ. utriusque Socii, *GETA BRITANNICUS. Accedit Domus Severianæ Synopsis Chronologica: & de Icuncula quondam M. Regis Ælfredi Dissertatio.* 8vo. Ifcæ Dumnoniorum. MDCCXV.

**T**HE Author, having some <sup>1</sup> Years since publish'd a Comment on *Julius Vitalis* his Epitaph, which, (together with his Monument) is to be seen at *Bath*; does now present the publick with another Volume of *Belgic Antiquities*; intending hereby, to illustrate part of a Statue, which was found likewise near that City, and is at this time immured near the Monument aforesaid, at the eastern End of the Abby-Church, looking toward the Grove.

This Fragment of an Equestrian Statue, is in *Basse Reliefe*: The Rider has in his right Hand a *Hasta pura*, and a *Parma* in his left; as in *Fig. 1.* of the Book. It appears from <sup>2</sup> *Dio* that *Caius* and *Lucius*, Cæsars, (the Nephews, and adopted Sons of *Augustus*) had each of them a *Parma* and an *Hasta* given him: and there being no Instance of this Honour paid to any of an inferiour Rank among the *Romans*, but only to such as were of very great Quality; if not to *Cæsars* only; we are from hence be allowed to think, *That this Statue represented some Person of that Quality.*

But to discover the particular Person, (if it might be done) the Author compared a very good Draught he had procured of this Horseman, with such *Roman* Coyns,

<sup>1</sup> Ifcæ Dunmon: MDCCXI.

<sup>2</sup> Lib. LV.

as He could meet with. This Comparison shewed a great Resemblance between the Face in the Statue, and that in two of *Geta's* Coyns.

This Argument, drawn from the Similitude of Faces (of great force to determine the Reader's Judgment in favour of *Geta*) is farther confirmed by the Horse; a Creature of which *Geta* was very fond; insomuch, as that He affected to be represented under the Figure of *Castor*, (as the *Roman* Emperors often were under the Figures of their Gods) of whom it is said, *Castor gaudet Equis*; — Of this Figure there is in <sup>3</sup> *Oiselius*, a Coyn of *Geta's*, very much to this purpose; represented *Tab. IV. fig. 5.* of this Book.

These things bring to mind, the Authority which *Geta* had in *South-Britain*: where (as <sup>4</sup> *Herodian* affirms) all matters were under his Administration, during the *Stay* which *Severus* and *Caracalla* made in the North; which was a Year, or more. In this time, *Geta* had it in his Power, to do many things, in favour of Cities and Countreys, here in the South. The great Generosity of his Mind prompted Him to publick Works; such as are, to this day, attested by <sup>5</sup> *Inscriptions*, with his Name in them: and it is highly probable, [That this Statue was erected to *Geta* on some such account.]

If this be granted, (as from the concurrence of so much, and so good Testimony, it seems highly probable) here is a large and pleasant View opened into Antiquity; not of late taken notice of by any Writer: It shews, that *Geta* was a great Benefactor to *old Bath*; either by laying, in a perfect Morass, the Foundation of that Town; or by preserving the *Hot-Springs* entire, from the influx of

<sup>3</sup> *Tab. XLII. 1.*

<sup>4</sup> *Lib. III. Sect. XLVIII.*

<sup>5</sup> *Gruteri Thes. Inscriptionum, pag. CLVII. 2, 3, 4, 6.*

other Waters; or both : Works of great Munificence, and becoming *Geta's* Spirit. By these, or some such Ways, it is probable, this People was obliged to *Geta*; but no one is more probable, than that of preserving the *Aquæ Calide* ; which were in those days so famous, as to give a Denomination to the place. It is well known, That *Rome* had her *Thermæ Severiana* and *Antoniniana*, so called from their respective Founders ; the former being built by *Severus*, the Father ; the latter by *Antoninus*, the Brother, of *Geta* : so that to take care of Baths, was a sort of Greatness, that Family seemed to delight in ; and *Geta* may reasonably be supposed, to have his share of this Delight.

From the great probability of this Opinion, the Author has, out of Love to his native Country, and the Honour due to *Geta*, collected and put together, what He can meet with relating to that Emperor. He has made a new Edition of *Geta's* Life, from the *Historia Augustæ Scriptores* ; restoring it to its true Author, *Julius Capitolinus* ; and explaining it, with the Notes of *Casaubon*, *Gruter*, and *Salmasius* ; to which he has added some of his own. He has reprinted all the Inscriptions he can meet with, of *Geta's*, and many of his Coyns ; with short Notes on both.

After all this, He is not so far engaged in this Opinion, but that if, (by any Inscription on the Basis of this Statue, or any other testimony) it shall hereafter appear, that this Fragment deserves another Explication, he shall readily comply with any such clearer Testimony : being no way disposed, to give farther credit to this broken Monument, than shall answer the imperfect Condition it is now in.

To this Dissertation, *de Geta Britannico*, He has added the Chronology of his illustrious House ; shewing, how his Father, *Severus*, from a private Gentleman in *Africa*,

came by degrees to be Emperor of *Rome* ; and indeed one of the Greatest, that ever *Rome* had : How He, with his two Sons, *Bassianus* and *Geta*, (three *Roman* Emperors) resided, at one and the same time, here in *Britain*) and from hence sent their Imperial Edicts, Orders, and Dispatches, into all parts of the Empire : and after an amazing Greatness of about twenty four Years, and a Course of almost all Virtues and Vices, at length tumbled down ; submitting to the Accidents and Fate of other Men ; and were all buried at *Rome*, in the *Septizodium* built by *Severus*.

To these Memoirs of *Geta*, the Author has subjoined a Discourse, concerning that curious *Cimelium*, which was, some Years since, found at *Athelney* in *Somerset*. It did belong to K. *Ælfred*, and is now in the Possession of Col *Palmer* of *Fairfield*, in that County. Beside the critical use made of it, by the learned<sup>1</sup> Dr. *Hickes*, our Author writes of it, as an undeniable Instance of the use of Images, coming from the Heathens into the Christian Church.

The Book is adorned with several Cuts, of the Broken Statue at *Bath*, of two of *Geta's* Silver-Coyns, of the *Septizodium Severi*, (out of *Perac*) and three sides of the *κεφάλιον Ælfredi*.

---

<sup>1</sup> In Thesaurο Ling. Septentrionalinm non ita pridem edito.

## E I N I S.

---

L O N D O N: Printed for W. I N N Y S at the *Prince's*  
Arms in *St. Paul's Church-yard*. MDCCXVI.

# PHILOSOPHICAL TRANSACTIONS.

For the Months of Jan. Febr. and March 1716.

## The CONTENTS.

- I. *An Account of several Nebulæ or lucid Spots like Clouds lately discovered among the Fixt Stars by help of the Telescope.*
- II. *Nova & tuta Variolas excitandi per Transplantationem Methodus, nuper inventa & in usum tracta : Per Jacobum Pylarinum, Venetum, M. D. & Reipublicæ Venetæ apud Smyrnenſes nuper Consullem.*
- III. *Problematis olim in Actis Eruditorum Lipsiæ propositi Solutio Generalis.*
- IV. *Some late curious Astronomical Observations communicated by the Reverend and Learned Mr. James Pound, Rector of Wansted, and R. Soc. Soc.*
- V. *An Account of the late surprizing Appearance of the Lights seen in the Air, on the sixth of March last; with an Attempt to explain the Principal Phænomena thereof; As it was laid before the Royal Society by Edmund Halley, J. V. D. Savilian Professor of Geom. Oxon, and Reg. Soc. Secr.*

I. *An Account of several Nebulæ or lucid Spots like Clouds, lately discovered among the Fixt Stars by help of the Telescope.*

**I**N our last we gave a short Account of the several New-Stars that have appeared in the Heavens, within the last 150 Years, some of which afford very surprizing Phænomena. But not less wonderful are certain luminous Spots or Patches, which discover themselves only by the Telescope, and appear to the naked Eye like small Fixt Stars; but in reality are nothing else but the Light coming from an extraordinary great Space in the Ether; through which a lucid *Medium* is diffused, that shines with its own proper Lustre. This seems fully to reconcile that Difficulty which some have moved against the Description *Moses* gives of the Creation, alledging that Light could not be created without the Sun. But in the following Instances the contrary is manifest; for some of these bright Spots discover no sign of a Star in the middle of them; and the irregular Form of those that have, shews them not to proceed from the Illumination of a Central Body. These are, as the aforesaid New Stars, Six in Number, all which we will describe in the order of time, as they were discovered; giving their Places in the Sphere of Fixt Stars, to enable the Curious, who are furnished with good Telescopes, to take the Satisfaction of contemplating them.

The first and most considerable is that in the Middle of *Orion's Sword*, marked with  $\theta$  by *Bayer* in his *Uranometria*, as a single Star of the third Magnitude; and is so accounted by *Ptolemy*, *Tycho Brahe* and *Hevelius*: but in reality

reality two very contiguous Stars environed with a very large transparent bright Spot, through which they appear with several others. These are curiously described by *Hugenius* in his *Systema Saturnium* pag. 8. who there calls this brightness *Portentum, cui certe simile aliud nusquam apud reliquas Fixas potuit animadvertere* : affirming that he found it by chance in the Year 1656. The Middle of this is at present in  $\Pi$   $19^{\circ}.00$ , with South Lat.  $28^{\circ}\frac{3}{4}$ .

About the Year 1661 another of this sort was discovered (if I mistake not) by *Bullialdus*, in *Cingulo Andromedæ*. This is neither in *Tycho* nor *Bayer*, having been omitted, as are many others because of its smallness : But it is inserted into the Catalogue of *Hevelius*, who has improperly call'd it *Nebulosa* instead of *Nebula* ; it has no sign of a Star in it, but appears like a pale Cloud, and seems to emit a radiant Beam into the North East, as that in *Orion* does into the South East. It precedes in Right Ascension the Northern in the Girdle, or  $\nu$  *Bayero*, about a Degree and three Quarters, and has Longitude at this time  $\Upsilon$ .  $24^{\circ}.00'$  with Lat. North  $33^{\circ}\frac{1}{2}$ .

The Third is near the Ecliptick between the *Head* and *Bow* of *Sagittary*, not far from the Point of the Winter Solstice. This it seems was found in the Year 1665 by a German Gentleman *M. J. Abraham Ihle*, whilst he attended the Motion of *Saturn* then near his *Apelion*. This is small but very luminous, and emits a Ray like the former. Its Place at this time is  $\Psi$ .  $4^{\circ}\frac{1}{2}$  with about half a Degree South Lat.

A fourth was found by *M. Edm. Halley* in the Year 1677, when he was making the Catalogue of the Southern Stars. It is in the *Centaur*, that which *Ptolemy* calls  $\delta$   $\epsilon\eta$   $\tau\iota$   $\varsigma$   $\beta$   $\nu\omicron\tau\epsilon$   $\epsilon\kappa\phi\upsilon\sigma\omega\varsigma$ , which He names *in dorso Equino Nebula* and is *Bayer's*  $\omega$  ; It is in appearance between the fourth and fifth Magnitude, and emits but a small Light for its Breadth,



and is without a radiant Beam; this never rises in *England*, but at this time its Place is  $m\ 5^{\circ}\frac{3}{4}$  with  $35^{\circ}\frac{1}{2}$  South Lat.

A Fifth was discovered by Mr. *G. Kirch* in the Year 1681, preceding the Right Foot of *Antinous*: It is of its self but a small obscure Spot, but has a Star that shines through it, which makes it the more luminous. The Longitude of this is at present  $w. 9^{\circ}$ . *circiter*, with  $17^{\circ}\frac{1}{2}$ . North Latitude.

The Sixth and last was accidentally hit upon by M. *Edm. Halley* in the Constellation of *Hercules*, in the Year 1714. It is nearly in a Right Line with  $\zeta$  and  $\eta$  of *Bayer*, somewhat nearer to  $\zeta$  than  $\eta$ : and by comparing its Situation among the Stars, its Place is sufficiently near in  $m\ 26^{\circ}\frac{1}{2}$ . with  $57^{\circ}\ 00$ . North. Lat. This is but a little Patch, but it shews it self to the naked Eye, when the Sky is serene and the Moon absent.

There are undoubtedly more of these which have not yet come to our Knowledge, and some perhaps bigger but though all these Spots are in Appearance but little, and most of them but of few Minutes in Diameter; yet since they are among the Fixt Stars, that is, since they have no Annual Parallax, they cannot fail to occupy Spaces immensely great, and perhaps not less than our whole Solar System. In all these so vast Spaces it should seem that there is a perpetual uninterrupted Day, which may furnish Matter of Speculation, as well to the curious Naturalist as to the Astronomer.

II. *Nova & tuta Variolas excitandi per Transplantati-  
onem Methodus, nuper inventa & in usum tracta :  
Per Jacobum Pylarinum, Venetum, M. D. &  
Reipublicæ Venetæ apud Smyrnenfes nuper Con-  
sulem.*

**O**perationem Medicam inventu non minus quàm e-  
ventu mirandam Orbi literario pandimus ; Non  
à Physicæ cultoribus, aut à doctis in Apollinea arte viris,  
sed à plebea rudique gente in humani generis adjumentum,  
in sævissimi morbi solamen detectam, verustis Scholarum  
Lucubrationibus, sedulis recentiorum investigationibus  
ignotam ; sed quæ ex innocentioris & ἀφιλοσόφου fa-  
milix penu defluxit. Verus ignoratur ejus adinventor :  
in Græcia tamen, præcisè in Thessalia, primò invaluisse  
certissimum est ; hinc in propinqua successivè serpendo  
loca & civitates, in Byzantinam tandem irrepsit urbem ;  
ubi latuit quidem initio per aliquot annos, rarò quoque,  
& inter humiliores dumtaxat recepta : Immaniter autem  
grassante nuper Variolarum epidemia, latius innouescere  
cœpit ; Numquam tamen sublimiores ausa est ingredi au-  
las ; donec Nobilis quidam nec obscurus inter præstanti-  
ores Græcos, & ex antiquo Caryophyllorum stipite cla-  
rus, mihi verò intimiori amicitix titulo notus, anno salutis  
1701. sub hyemis finem, serio mē quidnam de hac in-  
fitione sentirem, consuluit ; & an ad eandem in qua-  
tuor propriis filiis celebrandam præstare assensum : Nam  
tū temporis lethaliter totam ferè civitatem morbus hic  
invaserat ; qui summum ei de natorum salute metum in-  
cutiendo, anxium valdè reddiderat. Verū quid ipse  
super ignota re decernerem, nulla præcedente novissimæ  
hujusce methodi notitia, penitus ignorare me dixi ; ac  
simul Operatoris conveniendi copiam petii. Triduo per-  
acto, cum ad amicum denuò accessissem, & de eadem

materia sermo iteratò inter nos esset initus; Ecce paulo post mulier Græca ad decentiam satis composita cubiculum intravit; quæ totam operationis seriem, modum, locum, tempus, cæterasque circumstantias, ut ego deinceps aperiam, clarè satis latèque nobis exposuit; quamquàm ipsa veram ex insitione excitationis Variolarum causam haud intellexerit: His experimenta & casus innumeros tutò semper & ad salutarem eventum perductos annexit; è quibus aliquot (omnes enim quis potuisset in urbe amplissima exquirere?) verissimos esse ex assertoribus fide dignis deprehendi: Idcirco re bene pensitata, rationi & naturæ haud absconam omninò comperi: præsertim autem casibus jam dictis permotus, amico jam fervidius post aliquot dies consilium iterùm expetenti, mè haud alienum, sub levi tamen hæsitantia, præbui; Quâ, tamquam dato assensu, arreptâ, & deservando regimine toto ægrotationis tempore satis edoctus, insitionem per mulierem Græcam in quatuor filiis audacter instituit: quorum tres natu minores (quinguennes, & vix septennes) leviter ægrotarunt; paucisque apparentibus pustulis post hebdomadam, febre penitus & periculo evaserunt: Ætate verò major, octavum super decimum agens annum, graviter decubuit: Nam continenti febre & malignante correptus, superveniente difficilium symptomatum syndrome, plusculisque quamquàm non copiosis exanthematibus obrutus, vix post decimum quartum diem morbum elusit: Quod ego atrabilari ejus temperamento, succisque pravis, ut & neglectæ prius (contrà datam admonitionem) corporis expiationi tribuendum velim. Felix operationis eventus mirum quam multas nobiliorum familias ad imitationem traxit; Ut hodie sine hæsitantia, præter timidiusculos aliquos, unusquisque transplantationis emolumentum sentire velit. Soli Turcæ, utpote Fati decretis addicti minusque dociles, hanc neglexerunt hucusque.

Naturalis est penitus hæc Operatio, nulloque obducta superstitionis fuco; quamvis ipsum Transplantationis No-

men

men prima facie hæsitantiam pariat. Differt toto cœlo à Curationibus Sympatheticis ; eò magis à Magnetismo illo transplantatorio, per quem Morbi ex uno subiecto (mediate imaginaria quadam, gratis efficta, & imperceptibili Mumia) in aliud traduci dicuntur ; qua de re Tenzelius, Bartholinus, Maxuellus, Ermullerus, aliique ex Recentioribus, docti aliàs Viri, agunt sedulò ; qui vetustas Antiquorum in Medicina quisquilias expurgandas esse cum jactitent ; inter quisquilias ipsi quandoque se volunt, novissima vanitatis amurca venerandam hætenus purissimamque Scientiam deturpantes. Quare, ut verum fatear, quemadmodum Operationes hæ Magneticæ, vel Sympatheticæ superstitiosæ vanitatis suspicione non carent (ut in Unguento Armario, Pulvere sympathetico, & similibus), utpotè extra activitatis sphæram in distans agentes ; ità Variolarum Transplantatio, vera, mera, pura Physica est ; quia puris mediis Physicis, & ad oculum patentibus, nec non ipso sensibili contactu completur ; ut è mox dicendis clariùs elucescet.

Hujusmodi igitur Variolarum excitatio fit per Metaphoricè sic dictam Infectionem sive Transplantationem ; quæ nihil aliud est, quam fermenti morbifici seu puris ex Variolis extracti in corpus sanum, per vulnuscula ad hoc facta, insertio.

Physicus excitationis modus hoc pacto succedit. Intrusum in vulnuscula pus veri fermenti suscipit indolem ; Hinc beneficio circulationis per vasa & canales proprios ad sanguinis massam delatum, dispositas ad hoc particulas, & delitescente vitio turgidas statim aggreditur, inficit, venenumque communicando latitans in illis seminarium fermentativum excitat, agit, aëuat, inque motum ciet ; Unde ebullitio universalis, seu fermentatio oritur ; Vi cujus impuriore & heterogeneæ partes separatæ criticè protruduntur ad cutem ; natura interim placidè virtute talis operationis totum opus moderante.

Sed ad Transplantationem ipsam, & ejus celebrandæ formam properandum ; modum quò eadem Mulier Transplantatrix tutissimè operabatur fideliter describendo, ordinem, cæteraque omnia ; ex quibus regula quædam institui poterit pro operatione hac obeunda. Cæterùm quamvis de omnibus oculatus Testis, ut ingenuè fatear, esse non possim ; ex Operatricis tamen ore multa, plura ex fideli relatione transumpsi ; plurima & potiora ipsemet observavi. Omitto quæ ad majorem confirmationem universalis fama canit. Quibus omnibus præstandam esse fidem candidè ac strenuè assevero.

Ergo primò tempus ad celebrandam insitionem opportunum sèligendum est ; Quod secundùm Operatricem hybernium desideratus ; & non nisi tali tempore ipsa insitionem instituebat : Vernum ego pariter idoneum crediderim, propter clementiorem aeris temperiem.

Secundò selectissimum adhibet fermentum ; Pus scilicèt inferendum non ex quolibet subjecto recipit ; sed Variolis epidemicè grassantibus, è pustulis jam maturis decumbentis alicujus pueruli alias *ευσάρκω*, iisque benignis, punctione illud extrahit exprimitque ; & in conchulam aliquam vel vitreum vasculum mundissimum, nec nimis actu frigidum reponit reconditque ; quod Vasculum bene sartum tectum in pedissequi sinum fovendum intrudit ; mox sine mora ad operationem properat : Pus ex insititiis rejicit, ut inefficax. Quod tamen ego benignioris indolis, nec minoris interim energiæ fecerim : qua in re experientia consulenda.

Tertiò, temperatissimum vult patientis inhabitandum cubiculum quoad aeris modificationes.

Quartò, ad operationem jam celebrandam accedens mulier, frontem in confinio capillorum & quidem medio in loco ; mentum & utrasque genas acu ferrea vel aurea pungit ; non rectà, sed obliquè impingendo, cutemque acuta cuspide à subjecta carne aliquantillùm separando.

hinc

hinc eadem acu pus jam præparatum in vulnusculum instillat è vasculo, intruditque ; superinducta per fasciam ligatura : Manus item ambas in metacarpis, pedes in metatarsis eodem modo ferit, pusque inferit, fasciaque leniter stringit ; serio imponendo patienti, ne partes illas scalpat madefaciatve. Potius carnosiora pungerem loca, quatenus inflammationibus dolorique minus obnoxia, nec tendinibus intertexta.

Præter hanc operandi formam cæteri omnes rejiciuntur modi, utpotè absconi, inusitati, malè succedentes, infelicisque exitus.

Interim lectulo moderatè manendum, neque plus quàm opus fuerit jacendum.

Quintò bonum in sex rebus non naturalibus regimen, præcipue in victù, injungit ; Non solum enim vino & carnibus, verum etiam earumdem jusculo rigorosè patientes ad quadragesimum diem interdicat : Pluribusque monitum non curantibus sæpius malè successit ; nam ad oculos, pœna erroris, novas erupisse pustulas, aliaque non parvi discriminis symptomata supervenisse, visum est.

Sic ritè peracta transplantatione, non omnibus eodem temporis intervallo suscitari solent variolarum symptomata ; Variè enim fermentum agit ; serius vel citius, prout unicuique proprium favet temperamentum, ætas, robur : Quamquàm Variolæ ipsæ, in septimo ferè tèmper apparere incipiant, qui dies vere criticus est. Nec defutere, quod rarò contingere solet, quibus statim primo die effloruerint.

Symptomata ægrotantibus evenientia variant secundùm temperamentorum diversitatem, fæcorum in massa sanguinea habitudinem, & particularem in sagulis naturæ dispositionem : remissiora nempe vel mentiora ingruant ; At communiter grassantibus non dissimilia, quamvis clementiori ut plurimum facie : Plures vix alterationem læsionemve sentiunt aliquam.

**Excitatae Variolæ** ferè semper sunt de genere **Distinctarum** ; nec numero multæ ; Decem, ut plurimum viginti, triginta, rarò ad centum, rarissimè ad ducentas erumpunt.

Notandum primò nonnullos, unico dumtaxat vulnusculo ad brachium inflicto contentos, excitasse variolas ; paucisque apparentibus pustulis præservatos tamen imposturum fuisse à contagio.

Notandum secundò accidisse interdum, ut ex infitione nullæ penitus excitatæ fuerint Variolæ, vel ob non præexistentem ullam prorsus variolicam in corpore dispositionem, vel ob enervatum infractumque fermenti contagium : At postea grassante populariter morbo, correpta sunt promiscuè ejusmodi corpora jam infitionem passa, communi cæterorum sorte.

Tertiò, infersionis loca seu vultuscula in pustulas semper evadere solent : Quibusdam verò excrescunt in purulenta tubercula, nullis interim apparentibus pustulis ; Nonnullis in apostemata quidem majora degenerant magnam puris copiam effundentia : Non semel eadem loca, in pedibus præcipuè manibusque, summo cum dolore intumescunt ; pureque effuso subsident, iterumque in tumorem attolluntur. Quibusdam, rarissimè tamen, ad glandulosas partes & emunctoria, post aliquod tempus, abscessus emergunt, ac suppurantur paulatim : ludente sic in diversiformi corporum crassi natura.

Postremò, nunquam ferè ex transplantatione hac fuisse quid accidisse observatum fuit hætenus ; etiamsi in quocumque sexu, temperamento, ætate celebrata fuerit ; quinimò, ritè recteque tractata, & in corporibus perperitum Medicum aprè præparatis, certissimam promittit salutem. Variolæ enim hoc modo excitatæ benignioris sunt indolis, quam sunt illæ quæ populariter grassantur ; Utporè ex fermento, seu contagio, omni malignitate carente promotæ : Ebullitio, per quam massa sanguinis agitur ac totum opus perficitur, blandè non violenter,

moderante natura, conamina sua molitur; Sed præter hæc, tempus ad operationem atque anni tempestas magis idonea pro transplantatione ad libitum eligi, ut & corpus infitioni subjiendum congruis adminiculis ad recipiendam illam ex arte præparari disponique poterit; Quod revera maximi ad salutarem faustumque morbi successum momenti censei debet.

De hac re vide etiam *Philos. Transf.* No. 339.

### III. *Problematis Mathematicis Anglis nuper propositi Solutio Generalis.*

**I**N Actis Eruditorum pro mense *Octobri* Anni 1698. pag. 471. D. *Johannes Bernoullius* hæc scripsit. Methodum quam optaveram generalem secandi  
 “ [Curvas] ordinatim positione datas sive algebraicas sive  
 “ transcendentales, in angulo recto sive obliquo, invariabili sive data lege variabili, tandem ex voto erui: cui,  
 “ *Leibnitio* approbatore, ne  $\gamma\psi$  addi posset ad ulteriorem perfectionem, & vel ideo tantum quod perpetuo  
 “ ad æquationem deducat: in qua si interdum indeterminatæ sunt inseparabiles, methodus non ideo imperfectior est, non enim hujus sed altius est methodi indeterminatas separare. Rogamus igitur fratrem ut velit suas  
 “ quoque vires exercere in re tanti momenti. Suscepti laboris non poenitebit, si felix successus fructu jucundo  
 “ compensaverit. Scio relicturum suum quem nunc fover modum, qui in paucissimis tantum exemplis adhiberi  
 “ potest.

Hi tres Viri celeberrimi sese, jam ab annis quatuor vel quinque circiter in solvendis hujusmodi Problematis exercebant. Absque spiritu divinandi eandem solutionem cum *Bernoulliana* tradere difficile fuerit. Sufficit quod Solutio sequens sit generalis, & ad æquationem semper deducat.

P R O B.



## P R O B L E M A.

*Quæritur Methodus generalis inveniendi Seriem Curvarum, quæ Curvas in serie alia quacumque data constitutas, ad angulum vel datum vel data lege variabilem secabunt.*

*Solutio.*

Natura Curvarum secundarum dat Tangentes earundem ad intersectionum puncta quæcumque; & anguli intersectionum dant perpendiculara Curvarum secantium; & perpendiculara duo coeuntia, per concursum suum ultimum, dant centrum Curvaminis Curvæ secantis ad punctum intersectionis cujuscumque. Ducatur Abscissa in situ quocumque commodo, & sit ejus Fluxio Unitas; & positio perpendiculari dabit Fluxionem primam Ordinatæ ad Curvam quæsitam pertinentis; & Curvamen hujus Curvæ dabit Fluxionem secundam ejusdem Ordinatæ. Et sic Problema semper deducetur ad æquationes. Quod erat faciendum.

*Scholium.*

Non hujus sed alius est methodi æquationes reducere, & indeterminatas separare, absolutè si fieri possit, sin minus per Series infinitas. Problema hocce, cum nullius fere sit usus, in Actis Eruditorum annos plures neglectum & insolutum mansit. Et eadem de causa solutionem ejus non ulterius prosequor.

IV. *Some late curious Astronomical Observations communicated by the Reverend and Learned Mr. James Pound, Rector of Wansted, and R. Soc. Soc.*

*The Occultation of Jupiter by the Moon observed at Wansted the 14th of July in the Morning, 1715.*

**H**AVING after Midnight carefully corrected the Clock by no less than ten Observations of the Altitude of the *Lucida Arietis*, the Error thereof was found 5'. 13". too fast, the extreams not differing above 6": And in the morning about 7<sup>h</sup>, by as many Altitudes of the *Sun*, with a like Agreement, the same Error was found 5'. 14", to be deducted from the Times shewn by the Clock.

Julii 13 <sup>o</sup> . P. M. N.	Time by the Clock.	Time cor- rect.
The Third Satellite of <i>Jupiter</i> was hid by the Moon	h. ' "	h. ' "
	13 27 33	13 22 20
The first Satellite was hid	13 32 35	13 27 22
The Second Satellite was hid	13 34 25	13 29 11
The first Contact of the Limbs of ☿ and ♃	13 34 54	13 29 41
<i>Jupiter</i> wholly hid	13 36 23	13 31 10
The Third Satellite came out from behind the dark side of the Moon	14 7 25	14 2 12
The first Satellite	14 12 25	14 7 12
The Second Satellite	14 14 38	14 9 25
The first Limb of <i>Jupiter</i> came out	14 14 45	14 9 32
The following Limb of <i>Jupiter</i> , or last Contact	14 16 15	14 11 2
The fourth Satellite emerged	14 18 49	14 13 36
R r r		<i>Jupiter</i>

*Jupiter* and the Satellites were to the Northward of the visible Way of the Moon's Center.

This Occultation was observed through a Telescope, in which the Focal Length of the Object Glass was  $14\frac{1}{2}$  Feet, and of the Eye Glass  $2\frac{3}{4}$  Inches. And the Aperture of the Object Glass was  $1\frac{1}{10}$  Inch.

I could perceive no Colours on *Jupiter's* Limb, either at his immersion or Emerfion, when the Axis of the Tube was directed to him.

Obsev.	Apparent Time	<i>An Eclipse of the Moon observed at Wansted October 30. 1715.</i>	
	h. ' "		
1	15 09 00	The Eclipse had been for some time begun	, "
2	17 00	The Moons Diameter measured by a Micrometer was	34 04
3	22 25	The Chord connecting the Horns	30 28
4	35 45	The inlightned Part of the Diameter continued to the Chord between the Horns	19 58
5	43 24	The inlightned Part of the Diameter	13 52
6	49 50	The same repeated	12 02
7	52 43	The same repeated	11 44
8	56 51	The inlightned part of the Diameter continued to the Chord between theHorns	15 22
9	59 27	The inlightned Part of the Diameter	10 35
10	16 04 04	The same repeated	9 43
11	18 34	The same again repeated	9 07
12	23 45	The Chord between the Horns	32 35
13	26 30	The same repeated	33 07
			14

	h. ' "				' "
14	16	31	16	The same again At which time also the Shade passed thro' the middle of <i>Schikardus</i> .	33 19
15		37	15	The Chord between the Horns, agreeing with the D's Diameter	33 57
16		40	45	The inlightned part of the Diameter	11 56
17		43	40	The same produced to the Chord between the Horns	16 13
18		46	55	The same repeated	17 28
19		47	57	The inlightned part of the Diameter	13 38
20		52	57	The same	15 30
21		55	27	The Edge of the Shadow passed thro' the Middle of <i>Gassendus</i> .	
22		56	12	The inlightned part produced to the Chord between the Horns	19 58
23	17	02	45	The Chord between the Horns	32 12
24		8	20	The same repeated	30 28
25		10	39		29 56
26		13	00		28 31
27		15	29	The same again ———	27 33
28		17	37		26 35
29		19	35		25 36
30		21	47	The same again ———	24 38
31		23	24		23 39
32		24	54		22 40
33		26	27	The same again ———	21 41
34		27	57		20 42
35		29	08		19 43
36		30	20	The same again ———	18 44
37		31	07		17 45
38		32	04		16 46
39		32	50	The same again ———	15 47
40		34	12		13 48
41	17	35	20	The same again repeated	11 42

At 17<sup>h</sup>. 39. the Eclipse was thought to be ended ; and was visibly so at 17<sup>h</sup>. 41' : But by comparing the last Observations of the Chords between the Horns, it follows that the true End of the Eclipse was at 17<sup>h</sup>. 38. 20". At 17<sup>h</sup>. 43 the Moon's Diameter was 33' 40'.

The Middle cannot be supposed to be very accurately determined by these Observations, which were not sufficiently distant from the time of the greatest Obscuration. However by comparing several of them together, the Middle will be obtained, *viz.*

	h.	'	"
By Obs. 3. compared with Obs. 24. at	16	15	21
By Obs. 4. compared with Obs. 22. at	16	15	58
By Obs. 5. compared with 19. and 20 at	16	16	00
By Obs. 6. and 7. compared with 16. at	16	15	48

By reason of Clouds I could not see the Beginning of the Eclipse, nor make such Observations of the Moon's immersing into the Shadow as I did of her emerging out of it.

By Observation 11. compared with Observation 15. the Digits Eclipsed were  $8\frac{1}{4}$ .

The Angles were measured by a *Micrometer* in a 15 Foot Telescope. I have not considered how far they are consistent with one another ; they being set down here exactly as they were first taken.

This Eclipse is the more considerable, as happening very near the Moon's *Perigee*, and therefore useful to verify her *Anomaly* ; as also to limit the greatest Diameter of the Shadow of the Earth, and consequently the Parallax of the Moon. This may very properly be compared with that of the 19<sup>th</sup> of October, 1697, whose middle was at 7<sup>h</sup>. 41'. P. M. at London, and Quantity the same as now.

The

The Times by the Clock were 17.<sup>h</sup>. 45<sup>m</sup>. sooner than the apparent time, as was found by the following Observations of *Cor Leonis* and *Arcturus*, which through the Clouds were but just discernible.

Apparent Zenith Distance	Time by the Clock	Apparent Time by Calculat.	The Diffe- rence	
of <i>Cor</i> $\odot$				Mean Diff.
$^{\circ}$	h. ' "	h. ' "	' "	
70 16 $\frac{1}{2}$	13 32 43	13 50 35	17 52	
69 38	36 50	54 44	17 54	
69 09	40 06	57 51	17 45	17 50
68 40	43 09	14 00 59	17 50	
68 08	46 31	04 26	17 59	
of <i>Arctur.</i>				
65 19	17 37 40	17 55 24	17 44	
65 06	39 12	56 48	17 36	
64 41	41 49	59 29	17 40	17 40
63 47	47 40	18 05 17	17 37	
Clock too slow				17 45

The Latitude of *Wansted* is 51 $^{\circ}$ . 34'. Its Longitude is 8" in time Eastward from the Observatory at Greenwich.

The Account given of this Eclipse by the Reverend Mr. William Derham, who observ'd it at Upminster, is agreeable to this, as far as Clouds would permit him to observe.

---

V. *An Account of the late surprizing Appearance of the Lights seen in the Air, on the sixth of March last; with an Attempt to explain the Principal Phænomena thereof; As it was laid before the Royal Society by Edmund Halley, J. V. D. Savilian Professor of Geom. Oxon, and Reg. Soc. Secr.*

**T**HE *Royal Society* having received Accounts from very many Parts of *Great Britain*, of the unusual *Lights* which have of late appeared in the *Heavens*; were pleased to signify their Desires to me, that I should draw up a general Relation of the *Fact*, and explain more at large some Conceptions of mine I had proposed to them about it, as seeming to some of them to render a tolerable Solution of the very strange and surprizing *Phænomena* thereof. The Desires of the *Society* having with me the force of Commands, I shall not decline the Task : only premising that if, in delivering the *Etiology* of a Matter so uncommon, never before seen by my self, nor fully described by any either of the Ancients or Moderns, I fail to answer their Expectation or my own Desires; yet 'tis hoped a good History of the *Fact*, deduced partly from my own Observations, and partly collected from the uniform Relations of credible Persons, or from the Letters of such, may not be unacceptable to the Curious; and may perhaps excite the *Genius* of some more able *Meteorologist* to a more satisfactory Enquiry. The Account of this Appearance take as follows.

On

On *Tuesday* the sixth of *March*, *ſt. vet.* in the current Year 1716, (the Afternoon having been very ſerene and calm, and ſomewhat warmer than ordinary) about the Time it began to grow dark, that is much about 7 of the Clock, not only in *London*, but in all Parts of *England*, where the Beginning of this wonderful Sight was ſeen; out of what ſeemed a dusky Cloud, in the N. E. parts of the Heaven and ſcarce ten Degrees high, the Edges whereof were tinged with a reddiſh Yellow like as if the Moon had been hid behind it, there aroſe very long, luminous Rays or Streaks perpendicular to the Horizon, ſome of which ſeem'd nearly to aſcend to the Zenith. Preſently after, that reddiſh Cloud was ſwiftly propagated along the Northern Horizon, into the N. W. and ſtill farther Weſterly; and immediately ſent forth its Rays after the ſame manner from all Parts, now here, now there, they obſerving no Rule or Order in their riſing. Many of theſe Rays ſeeming to concur near the Zenith, formed there a *Corona*, or Image which drew the Attention of all Spectators, who according to their ſeveral Conceptions made very differing Reſemblances thereof; but by which compar'd together, thoſe that ſaw it not, may well comprehend after what manner it appeared. Some likened it to that Representation of *Glory* wherewith our Painters in Churches ſurround the Holy Name of God. Others to thoſe radiating *Starrs* wherewith the Breſts of the *Knights* of the moſt Noble Order of the *Garter* are adorned. Many compar'd it to the *Concave* of the great *Cupola* of *St. Paul's Church*, diſtinguiſht with Streaks alternably Light and obſcure. and having in the middle a Space leſs bright than the reſt, reſembling the *Lantern*. Whiſt others, to expreſs as well the Motion as Figure thereof, would have it to be like the Flame in an Oven reverberated and rouling againſt the arched Roof thereof: And ſome there were that thought it liker to that tremulous  
Light



Light which is cast against a Ceiling by the Beams of the Sun, reflected from the Surface of Water in a Basin that's a little shaken; whose reciprocal vibrating Motion it very much imitated. But all agree that this *Spectrum* lasted only a few Minutes, and show'd it self variously tinged with Colours, Yellow, Red and a dusky Green: Nor did it keep in the same Place; for when first it began to appear, it was seen a little to the Northwards of the *Zenith*, but by degrees declining towards the South, the long *Stria* of Light, which arose from all Parts of the Northern Semicircle of the Horizon, seemed to meet together, not much above the Head of *Castor* or the Northern *Twin*, and there soon disappeared.

After the first *Impetus* of this ascending Vapour was over, the *Corona* we have been describing appeared no more; but still, without any order as to Time, or Place, or Size, luminous *Radii* like the former continued to arise perpendicularly, now oftner and again seldomer, now here, now there, now longer, now shorter, Nor did they proceed at first out of a Cloud, but oftner would emerge at once out of the pure Sky, which was at that time more than ordinary serene and still. Nor were they all of the same Form. Most of them seemed to end in a Point upwards, like erect Cones; others like truncate Cones or Cylinders, so much resembled the long Tails of Comets, that at first sight they might well be taken for such. Again, some of these Rays would continue visible for several Minutes; when others, and those the much greater part, just shew'd themselves and died away. Some seem'd to have little Motion, and to stand as it were fix'd among the Stars, whilst other with a very perceptible Translation moved from East to West under the Pole, contrary to the Motion of the Heavens; by which means they would sometimes seem to run together, and  
at

at other times to fly one another ; affording thereby a surprizing Spectacle to the Beholders.

After this Sight had continued about an Hour and a Half, those Beams began to rise much fewer in Number and not near so high, and by degrees that diffused Light, which had illustrated the Northern Parts of the Hemisphere, seemed to subside, and settling on the Horizon formed the Resemblance of a very bright *Crepusculum* : That this was the State of this *Phanomenon*, in the first Hours, is abundantly confirmed by the unanimous Consent and concurring Testimony of several very worthy Persons no ways enclined to deceive. For by the Letters we have received from almost all the extream Parts of the Kingdom, there is found very little Difference in the Description from what appeared at *London* and *Oxford* ; unless that in the North of *England*, and in *Scotland*, the Light seemed somewhat stronger and brighter.

Hitherto I am forced to relate the Observations of others, wherein I fear many very material Circumstances may be omitted : and assuredly I am not a little concern'd that I had no Notice of this Matter, till between Nine and Ten of the Clock, being at that Time at a Friend's House, and no ways suspecting what past without Doors. But upon the first Information of the thing, we immediately ran to the Windows, which hapned to regard the *South* and *South-West* Quarter ; and soon perceived, that though the Sky was very clear, yet it was tinged with a strange sort of Light ; so that the smaller Stars were scarce to be seen, and much as it is when the Moon of four Days old appears after Twilight. And whilst we regarded the Heavens with attention, we perceived a very thin Vapour to pass before us, which arose from the precise *East* part of the *Horizon*, ascending obliquely, so as to leave the Zenith about 15 or 20 Degrees to the Northward. But the swiftness wherewith it proceeded

ded was scarce to be believed, seeming not inferiour to that of Lightning; and exhibiting, as it past on, a sort of momentaneous *Nubecula*, which discovered it self by a very diluted and faint Whiteness; and was no sooner formed, but before the Eye could well take it, it was gone, and left no Signs behind it. Nor was this a single appearance; but for several Minutes that we regarded it, about six or seven times in a Minute, the same was again and again repeated; these Waves of Vapour (if I may be allowed to use the Word) regularly succeeding one another, and, as we guess, at intervals very nearly equal; all of them in their Ascent producing a like transient *Nubecula*.

By this particular we were first assured, that the Vapour we saw, whatever it were, became conspicuous by its own proper Light, without help of the Suns Beams: for these *Nubecula* did not discover themselves in any other part of their passage, but only between the *South-East*, and *South*, where being opposite to the Sun they were deepest immerst in the Cone of the Earths Shadow; nor were they visible before or after. Whereas the contrary must have happened, had they borrowed their Light from the Sun.

We then made all the hast we could to a place where there is a free Prospect of the Northern Horizon. Being come there, not much past Ten of the Clock, we found, on the Western Side, *viz.* between the W. and N. W. the Representation of a very bright *Twilight*, contiguous to the Horizon; out of which there arose very long Beams of Light, not exactly erect toward the *Vertex*, but something declining to the South, which ascending by a quick and undulating Motion to a considerable Height, vanished in a little time, whilst others, tho' at uncertain Intervals, supply'd their Place. But at the same time; through all the rest of the Northern Horizon, *viz.* from the North-  
West

West to the true East, there did not appear any sign of Light to arise from, or joyn to, the Horizon ; but on the contrary, what appeared to be an exceeding black and dismal Cloud seem'd to hang over all that part of it. Yet was it no Cloud, but only the serene Sky more than ordinary pure and limpid, so that the bright Stars shone clearly in it, and particularly *Cauda Cygni* then very low in the *North* ; the great Blackness manifestly proceeding from the Neighbourhood of the Light which was collected above it. For the Light had now put on a Form quite different from all that we have hitherto described, and had fashioned it self into the Shape of two *Lamina* or Streaks, lying in a Position parallel to the Horizon, whose Edges were but ill terminated. They extended themselves from the *N.* by *E.* to the *North East*, and were each about a Degree broad ; the undermost about eight or nine Degrees high, and the other about four or five Degrees over it ; these kept their Places for a long time, and made the Sky so light, that I believe a Man might easily have read an ordinary Print by the Help thereof.

Whilst we stood astonished at this surprizing Sight, and expecting what was further to come, the Northern End of the upper *Lamina* by degrees bent downwards, and at length closed with the End of the other that was under it, so as to shut up on the Northside an intermediate Space, which still continued open to the East. Not long after this, in the said included Space, we saw a great Number of small Columns or whitish Streaks to appear suddenly, erect to the Horizon, and reaching from the one *Lamina* to the other ; which instantly disappearing were too quick for the Eye, so that we could not judge whether they arose from the Under or fell from the Upper, but by their sudden Alterations they made such an Appearance, as might well be taken to resemble the Conflicts of Men in Battle.

And much about the same time, to encrease our Wonder, there began on a sudden to appear, low under the Pole and very near due North, three or four lucid *Areas* like Clouds, discovering themselves, in the pure but very black Sky, by their yellowish Light. These, as they broke out at once, so after they had continued a few Minutes, disappeared as quick as if a Curtain had been drawn over them: Nor were they of any determined Figure, but both in Shape and Size might properly be compared to small Clouds illuminated by the full Moon, but brighter.

Not long after this, from above the aforesaid two *Lamine*, there arose a very great *Pyramidal Figure*, like a *Spear*, sharp at the Top, whose Sides were inclined to each other with an Angle of about four or five Degrees, and which seemed to reach up to the Zenith or beyond it. This was carried with an equable and not very slow Motion, from the N. E. where it arose, into the N. W. where it disappeared, still keeping in a perpendicular Situation, or very near it; and passing successively over all the Stars of the *Little Bear*, did not efface the smaller ones in the Tail, which are but of the Fifth Magnitude; such was the extream Rarity and Perspicuity of the Matter whereof it consisted.

This single Beam was so far remarkable above all those that for a great while before had preceeded it, or that followed it, that if the Situation thereof among the Circumpolar Stars had at the same Instant been accurately noted, for Example, at *London* and *Oxford*, whose Difference of *Longitude* is well known, we might be enabled thereby with some certainty to pronounce. by its *diversitas Aspectus*, concerning the Distance and Height thereof; which were undoubtedly very great, tho' as yet we can no ways determine them. But as this Phenomenon found all those that are skill'd in the Observation of the Heavens unprepared, and unacquainted with what  
was

was to be expected ; so it left all of them surprized and astonished at the Novelty thereof. When therefore for the future any such thing shall happen, all those that are curious in Astronomical Matters, are hereby admonished and entreated to set their Clocks to the apparent Time at *London*, for Example, by allowing so many Minutes as is the Difference of Meridians ; and then to note at the End of every half Hour precisely, the exact Situation of what at that time appears remarkable in the Sky ; and particularly the *Azimuths* of those very tall *Pyramids* so eminent above the rest, and therefore likely to be seen furthest : to the intent that by comparing those Observations taken in the same Moment in distant Places, the Difference of their *Azimuths* may serve to determine how far those *Pyramids* are from us.

It being now past Eleven of the Clock, and nothing new offering it self to our View, but repeated *Phases* of the same Spectacle ; we thought it no longer worth while to bear the Chill of the night-Air *sub dio*. Wherefore being returned to my House, I made haste to my upper Windows, which conveniently enough regard the N. E. Parts of Heaven, and soon found that the two *Lamine* or Streaks parallel to the Horizon, of which we have been speaking, had now wholly disappeared ; and the whole Spectacle reduced it self to the Resemblance of a very bright *Crepusculum* settling on the Northern Horizon, so as to be brightest and highest under the Pole it self ; from whence it spread both Ways, into the N. E. and N. W. Under this, in the middle thereof, there appeared a very black Space, as it were the Segment of a lesser Circle of the Sphere cut off by the Horizon. It seemed to the Eye like a dark Cloud, but was not so ; for by the Telescope the small Stars appeared through it more clearly than usual, considering how low they were : and upon this as a *Basis* our *Lumen Auroriforme* rested, which

which was no other than a Segment of a Ring or Zone of the Sphere, intercepted between two parallel lesser Circles, cut off likewise by the Horizon; or, if you please, the Segment of a very broad *Iris*, but of one uniform Colour; *viz.* a Flame-colour inclining to yellow, the Center thereof being about forty Degrees below the Horizon. And above this there were seen some Rudiments of a much larger Segment, with an Interval of dark Sky between, but this was so exceeding faint and uncertain that I could make no proper estimate thereof.

I was very desirous to have seen how this Phænomenon would end, and attended it till near Three in the Morning, and the rising of the Moon: but for above two Hours together it had no manner of Change in its Appearance, nor Diminution nor Encrease of light; only sometimes for very short Intervals, as if new Fuel had been cast on a Fire, the Light seem'd to undulate and sparkle, not unlike the rising of vaporous Smoak out of a great Blaze when agitated. But one thing I assured myself of by this Attendance and Watching, *viz.* that this *Iris*-like Figure did by no means owe its Origine to the Sun's Beams: for that about Three in the Morning, the Sun being in the Middle between the North and East, our *Aurora* had not follow'd him, but ended in that very Point where he then was: whereas in the true North, which the Sun had long past, the Light remained unchanged and in its full Lustre.

Hitherto I have endeavoured by Words to represent what I saw, but being sensible how insufficient such a verbal Description of a thing so extraordinary and unknown may be to most Readers, I have thought fit to annex a Figure exhibiting that particular Appearance of the two *Lamina*, which I saw at *London* between the Hours of Ten and Eleven: more especially, because I do

one that has taken notice of it. In this Figure *AB* is the under *Lamina*, somewhat broader and brighter than the upper *CD*: it had near its under Edge the *Lucida Lyra*, and below its Northern Extremity, on the Left-hand, *Cauda Cygni*: and as well above and below these, as in the intermediate Space between them, and indeed all round about that Part of the Heavens, the Sky was so unusually dark and black, as if all that *exotick Light* that had shew'd it self before, had been then collected into those two Streaks. Only at *Q* between the West and Northwest and no where else, out of a Brightness adjoining to the Horizon, there arose conical Beams as *M, L, N*, after the same manner as at first.

Whilst we stood looking on, the Streak *CD* at its Northern End bent downward, and joyned with the Under *AB* at *E*, and included the Space *DC E A B*, which still kept open at the other End towards the East. And in the mean time, out of the very clear Sky, some luminous Spots, situated and figured as in the Scheme at *G, G, G, G*, presented themselves to the Eye, in Colour much like the *Lamina*. These did not shew themselves all together, but came successively, yet so as two or three of them were seen at a time; and as their coming was instantaneous, so they went away in a Moment. At the same time likewise, the several little white Columns marked *F, F, F, F*, occupied that Part of the Space between the two Streaks next to *E*, and by their sudden and very irregular Motion, and the vanishing of some whilst others at the same time emerged, gave occasion to the Conception of those that fancy'd Battles fought in the Air. Lastly from about the middle of *CD*, there arose suddenly a Cone or Obelisk of a pale whitish Light, greater than any we had yet seen, as *H*; which moving from East to West, with a Motion sufficiently regular, was translated to *K*, in the *North West*, and there disappeared.

That



That we might by the same Scheme shew the Appearance of the last Hours, after Midnight ; the Reader is desired to take notice that we have made the Light at *Q*, much bigger than what appeared in the West about Ten of the Clock ; so as to represent truly that other. In this Case the Point *Q* must, by the Imagination, be supposed transferred to the Intersection of the Horizon and Meridian under the Pole. And that we might the better be understood in what follows, we have made this short Recapitulation as annex'd to, and explicative of, the Scheme, which could by no means be contrived to answer the wonderful Variety this Phænomenon afforded ; since even the Eye of no one single Observer, was sufficient to follow it in the Suddenness and Frequency of its Alterations.

Thus far I have attempted to describe what was seen, and am heartily sorry I can say no more as to the first and most surprizing Part thereof, which however frightful and amazing it might seem to the vulgar Beholder, would have been to me a most agreeable and wish'd for Spectacle ; for I then should have contemplated *propriis oculis* all the several Sorts of Meteors I remember to have hitherto heard or read of. This was the only one I had not as yet seen, and of which I began to despair, since it is certain it hath not happen'd to any remarkable Degree in this Part of *England* since I was born ; nor is the like recorded in the *English Annals* since the Year of our Lord 1574, that is above One Hundred and Forty Years ago, in the Reign of Queen *Elizabeth*. Then, as we are told by the Historians of those times, *Cambden* and *Stow*, Eye-Witnesses of sufficient credit, for two Nights successively, *viz.* on the 14th and 15th of *November* that Year, much the same wonderful Phænomena were seen, with almost all the same Circumstances as now.

Nor

Nor indeed, during the Reign of that glorious Princess, was this so rare a Sight as it has been since. For we find in a Book entituled a *Description of Meteors*, reprinted at London in the Year 1654, whose Author writes himself *W.F.D.D.* that the same thing, which he there calls *Burning Spears*, was seen at London on January 30. 1560; and again by the Testimony of Stow, on the 7<sup>th</sup> of October 1564. And from foreign Authors we learn, that in the Year 1575, the same was twice repeated in Brabant, viz. on the 13<sup>th</sup> of February and 28<sup>th</sup> of September; and seen and described by *Cornelius Gemma*, Professor of Medicine in the University of *Lovain*, and Son of *Gemma Frisius* the Mathematician. He, in a Discourse he wrote of the Prodigies of those Times, after several ill-boding Prognosticks, thus very properly describes the *Cupola* and *Corona* that he saw in the *Chasma* (as he calls it) of February *Paulo post undecunque surgentibus Hastis & flammis novis, flagrare cælum à Borea parte usque ad verticem videbatur: ac denique ne nihil qua contigerunt hætenus præfiguratum antea videretur, conversa est Cæli facies, per hora spatium, in Fritilli aleatorii speciem peregrinam; alternantibus sese caruleo & candido, non minore vertigine motusque celeritate, quam solares radii solent, quoties ab objecto speculo regeruntur.* Here it is not a little remarkable, that all these four already mentioned fell exactly upon the same Age of the Moon, viz. about two Days after the Change.

As to the other of September in the same Year 1575, these are the Words of *Gemma*. *Minus quidem horrendum, sed varia tamen magisque confusa nobis apparuit alterius Chasmatis forma, quarto Calendas Octobreis subsecuti, statim ab occasu Solis. Nam in illo visi sunt arcus illutres plurimi, ex quibus Hasta sensim eminentes, Urbesque turrita & Acies militares. Erant hinc radiorum excursus quaquaversum, & nubium fluctus & prælia: insectabantur invicem & fugiebant, facta in orbem conversione mirabili.* From hence tis ma-

nifest that this *Phenomenon* appeared in our Neighbourhood three several Times, and that with considerable Intervals, within the Campass of one Year ; though our *English* Historians have not recorded the two latter ; nor did *Gemma* see that of *November* 1574. as 'tis most likely by reason of Clouds. After this, in the Year 1580. we have the Authority of *Michael Mæstlin*, \* (himself a good Astronomer, and still more famous for having had the honour to be the great *Kepler's* Tutor in the Sciences) that at *Baknang* in the Country of *Wirtemberg* in *Germany*, these *Chasmata*, as he likewise stiles them, were seen by himself no less than seven times within the Space of twelve Months. The first of these, and most considerable, fell out on the very same Day of the Month with ours, viz. on *Sunday* the sixth of *March*, and was attended with much the same Circumstances, which, for Brevity's sake, I omit. And again the same things were seen in a very extraordinary manner on the 9th of *April* and 10th of *September* following : but in a less degree, on the 6th of *April*, 21st of *September*, 26th of *December* and 16th of *February*, 1581 : the last of which, and that of the 21st of *September* must needs have been more considerable than they then appeared, because the Moon being near the Full, necessarily effaced all the fainter Lights. Of all these however no one is mentioned in our Annals to have been seen in *England*, nor in any other place that I can find ; such was the neglect of curious matters in those Days.

The next in order that we hear of, was that of the Year 1621, on *September* the 2d. st. vet. seen all over *France*, and well described by *Gassendus* in his *Physicks*, who gives it the Name of *Aurora Borealis*. This, tho' little inferiour to what we lately saw, and appearing to the Northwards both of *Rouen* and *Paris*, is no where said to have been observed in *England*, over which the Light seemed to lie. And since then for above 80 Years, we have no Account

\* M. Mæstlin. lib. de Cometa 1580.

of any such Sight either from home or abroad ; notwithstanding that for above half that time, these *Philosophical Transactions* have been a constant Register of all such extraordinary Occurrences. The first we find on our Books, was one of small Continuance seen in *Ireland* by Mr. *Neve* on the 16th of *November* 1707. of which see *Phil. Transf.* No. 320. And in the *Miscellanea Berolinensia* published in 1710, we learn that in the same Year 1707, both on the 24th of *January* and 18th of *February*, *scilicet*. something of this kind was seen by *M. Olaus Römer* at *Copenhagen* : and again on the 23d of *February*, the same excellent *Astronomer* observed there such another Appearance, but much more considerable ; of which yet he only saw the Beginning, Clouds interposing. But the same was seen that Night by Mr. *Gotfried Kirch*, at *Berlin* above 200 Miles from *Copenhagen*, and lasted there till past Ten at Night. To these add another small one of short Duration, seen near *London*, a little before Midnight between the Ninth and Tenth of *August* 1708, by the Right Reverend *Philip* Lord Bishop of *Hereford*, and by his Lordship communicated to the *Royal Society* : so that, it seems, in little more than eighteen Months this sort of Light has been seen in the Sky, no less than five times ; in the Years 1707 and 1708.

Hence we may reasonably conclude that the Air, or Earth, or both, are sometimes, though but seldom and with great Intervals, disposed to produce this Phænomenon : for though it be probable that many times, when it happens, it may not be observed, as falling out in the Day-time, or in cloudy Weather, or bright Moon-shine : yet that it should be so very often seen at some times and so seldom at others, is what cannot well be that way accounted for. Wherefore casting about and considering what might be most probably the *Material Cause* of these Appearances ; what first occur'd was the Vapour of Water

rarified exceedingly by subterraneous Fire, and tinged with sulfureous Streams; which Vapour is now generally taken by our Naturalists to be the Cause of *Earthquakes*. And as Earthquakes happen with great Uncertainty, and have been sometimes frequent in Places, where for many Years before and after they have not been felt; so These, which we might be allowed to suppose produced by the Eruption of the pent Vapour through the Pores of the Earth, when it is not in sufficient Quantity, nor sudden enough to shake its Surface, or to open it self a Passage by rending it. And as these Vapours are suddenly produced by the Fall of Water upon the nitro-sulphurous Fires under Ground, they might well be thought to get from thence a Tincture which might dispose them to shine in the Night, and a Tendency contrary to that of Gravity; as we find the Vapours of *Gun-powder*, when heated in *Vacuo*, to shine in the Dark, and ascend to the Top of the Receiver though exhausted: the Experiment of which I saw very neatly performed by Mr. *J. Whiteside* Keeper of *Ashmole's Museum* in *Oxford*.

Nor should I seek for any other Cause than this, if in some of these Instances, and particularly this whereof we treat, the Appearance had not been seen over a much greater Part of the Earth's surface that can be thus accounted for. It having in this last been visible from the West Side of *Ireland* to the Confines of *Russia* and *Poland* on the East (nor do we yet know its Limits on that Side) extending over at least thirty Degrees of Longitude; and in Latitude, from about fifty Degrees over almost all the North of *Europe*; and in all Places exhibiting at the same time the same wonderful Circumstances, as we are informed by the Publick News. Now this is a Space much too wide to be shaken at any one Time by the greatest of Earthquakes, or to be affected by the Perspiration of that Vapour, which being included and wanting vent,

might

might have occasioned the Earth to tremble. Nor can we this Way account for that remarkable Particular attending these Lights, of being always seen on the Northside of the Horizon, and never to the South.

Wherefore laying aside all hopes of being able to explain these Things by the ordinary Vapours or Exhalations of the Earth or Waters, we are forced to have recourse to other sorts of *Effluvia* of a much more subtil Nature, and which perhaps may seem more adapted to bring about those wonderful and surprizingly quick Motions we have seen. Such are the *Magnetical Effluvia*, whose Atoms freely permeate the Pores of the most solid Bodies, meeting with no Obstacle from the Interposition of Glass or Marble or even Gold it self. These by a perpetual Efflux do, some of them, arise from the Parts near the Poles of the Magnet, whilst others of the like Kind of Atoms, but with a contrary Tendency, enter in at the same Parts of the Stone, through which they freely pass; and by a kind of Circulation surround it on all Sides, as with an Atmosphere, to the Distance of some Diameters of the Body. This thing *des Cartes* has endeavoured to explain (*Princip. Philosoph. Lib. IV.*) by the *Hypothesis* of the Circulation of certain skrewed or *striate Particles*, adapted to the Pores they are to enter.

But without enquiring how sufficient the *Cartesian Hypothesis* may be for answering the several Phænomena of the Magnet: that the Fact may be the better comprehended, we shall endeavour to exhibit the manner of the Circulation of the Atoms concerned therein, as they are exposed to view, by placing the Poles of a *Terrella* or *Spherical Magnet* on a Plane, as the Globe on the Horizon of a Right Sphere: Then strewing fine Steel dust or Filings very thin on the Plain all round it, the Particles of Steel, upon a continued gentle knocking on the under-side of the Plain, will by degrees conform themselves

to the Figures in which the Circulation is performed. Thus in *Fig. II.* Let *A B C D* be a *Terrella*, and its Poles *A* the South, and *B* the North ; and by doing as prescribed, it will be found that the Filings will lie in a Right Line perpendicular to the Surface of the Ball, when in the Line of the Magnetical Axis continued. But for about forty five Degrees on either side, from *B* to *G* or *I*, and from *A* to *H* or *K*, they will form themselves into Curves, more and more crooked as they are remoter from the Poles ; and withall more and more oblique to the Surface of the Stone : as our Figure truly represents, and as may readily be shewn by the *Terrella* and *Apparatus* for that Purpose in the *Repository* of the *Royal Society* Hence it may appear how this exceeding subtile Matter revolves ; and particularly how it permeates the Magnet with more force and in greater Quantity in the circumpolar Parts, entring into it on the one side, and emerging from it on the other, under the same oblique Angles : whilst in the middle Zone about *C* and *D*, near the Magnet's Equator (if I may use the Word) very few if any of these Particles do impinge, and those very obliquely.

Now by many and very evident Arguments it appears that our *Globe* of *Earth* is no other than one great Magnet, or (if I may be allowed to alledge an Invention of my own) rather two ; the one including the other as the *Shell* includes the *Kernel* (for so and not otherwise we may explain the changes of the Variation of the Magnetical Needle) but to our present Purpose the Result is the same. It suffices that we may suppose the same sort of Circulation of such an exceeding fine Matter to be perpetually performed in the *Earth*, as we observe in the *Terrella* ; which subtile Matter freely pervading the Pores of the *Earth*, and entring into it near its Southern Pole, may pass out again into the *Ether*, at the same Distance from the Northern, and with a like Force ; its Direction being  
still

still more and more oblique, as the Distance from the Poles is greater. To this we beg leave to suppose, that this subtle Matter, no otherways discovering it self but by its Effects on the Magnetick Needle, wholly imperceptible and at other times invisible, may now and then, by the Concourse of several Causes very rarely coincident, and to us as yet unknown, be capable of producing a small Degree of Light; perhaps from the greater Density of the Matter, or the greater Velocity of its Motion: after the same manner as we see the *Affluvia* of *Electrick* Bodies by a strong and quick Friction emit Light in the Dark: to which sort of Light this seems to have a great Affinity.

This being allowed me, I think we may readily assign a Cause for many of the strange Appearances we have been treating of, and for some of the most difficult to account for otherwise; as why these Lights are rarely seen any where else but in the North and never, that we hear of, near the Equator: as also why they are more frequently seen in *Iceland* and *Groenland*, than in *Norway*, though nearer the *Pole* of the *World*. For the Magnetical Poles, in this Age, are to the Westward of our Meridian, and more so of that of *Norway*, and not far from *Groenland*; as appears by the Variation of the Needle this Year observed, full twelve Degrees at *London* to the West.

The erect Position of the luminous Beams or *Strie* so often repeated that Night, was occasioned by the rising of the Vapour or lucid Matter nearly perpendicular to the Earth's Surface. For that any Line erected perpendicularly upon the Surface of the Globe, will appear erect to the Horizon of an Eye placed any where in the same spherical Superficies; as *Euclid* demonstrates in a Plain, that any Line erected at Right Angles to it, will appear to be perpendicular to that Plain from any Point thereof. That it should be so in the Sphere is a very pretty Proposition,

not



not very obvious, but demonstrated from *Prop. 5. Lib. I. Theodosii Spheric.* For by it all Lines erect on the Surface pass through the Center, where meeting with those from the Eye, they form the Plains of Vertical Circles thereto. And by the Converse hereof it is evident, that this luminous Matter arose nearly perpendicular to the Earth's Surface, because it appeared in this erect Position. And whereas in this Appearance (and perhaps in all others of the Kind) those Beams which arose near the *East* and *West*, as *L, M, N*, were furthest from the Perpendicular, on both sides inclining towards the *South*, whilst those in the *North* were directly upright: the cause thereof may well be explained by the Obliquity of the Magnetical Curves, making still obtuser Angles with the Meridians of the *Terrellâ*, as they are further from its Poles.

Hence also it is manifest how that wonderful *Corona* that was seen to the Southwards of the *Vertex*, in the Beginning of the Night, and so very remarkable for it's tremulous and vibrating Light, was produced; to wit, by the Concourse of many of those Beams arising very high out of the circumjacent Regions, and meeting near the Zenith: the *Effluvia* whereof they consisted mixing and interfering one with another, and thereby occasioning a much stronger but uncertain wavering Light. And since it is agreed by all our Accounts that this *Corona* was tinged with various Colours, 'tis more than probable that these Vapours were carried up to such a Height, as to emerge out of the Shadow of the Earth, and to be illustrated by the direct Beams of the Sun: whence it might come to pass that this first *Corona* was seen coloured and much brighter than what appeared afterwards in some Places, where the Sight thereof was more than once repeated, after the Sun was gone down much lower under the Horizon. Hence also it will be easily understood that this *Corona* was not one and the same in all Places, but was  
diffe-

different in every differing Horizon; exactly after the same manner as the Rainbow seen in the same Cloud is not the same Bow, but different to every several Eye.

Nor is it to be doubted, but the Pyramidical Figure of these Ascending Beams is Opticall: since according to all likelyhood they are parallel-sided, or rather tapering the otherway. But by the Rules of Perspective, their Sides ought to converge to a Point, as we see in Pictures the Parallel Borders of streight Walks, and all other Lines parallel to the Axis of Vision, meet as in a Center. Wherefore those Rays which arose highest above the Earth and were nearest the Eye, seemed to terminate in Cusps sufficiently acute, and have been for that reason supposed by the Vulgar to represent *Spears*. Others seen from afar, and perhaps not rising so high as the former, would terminate as if cut off with Plains parallel to the Horizon, like truncate Cones or Cylinders: these have been taken to look like the Battlements and Towers on the Walls of Cities fortified after the ancient manner. Whilst others yet further off, by reason of their great Distance, good part of them being intercepted by the Interposition of the Convexity of the Earth, would only shew their pointed Tops, and because of their Shortness have gotten the Name of *Swords*.

Next the Motion of these Beams, furnishes us with a new and, as it seems to me, most evident Argument to prove the diurnal Rotation of the Earth: (though that be a matter which, at present, is generally taken by the Learned to be past dispute) For those Beams which rose up to a Point, and did not presently disappear, but continued for some time, had most of them a sensible Motion, from East to West, contrary to that of the Heavens; the biggest and tallest of them, as being nearest, swiftest; and the more remote and shorter, slower. By which means, the one overtaking the other, they would some-

times seem to meet and jostle ; and at other times to separate, and fly one another. But this Motion was only Optical, and occasioned by the Eye of the Spectator being carried away with the Earth into the East ; whilst the exceeding rare Vapour of which those Beams did consist, being, as I take it, raised far above the Atmosphere, was either wholly left behind, or else followed with but part of its Velocity, and therefore could not but seem to recede and move the contrary Way. And after the same manner as the Stars that go near the Zenith, pass over those Vertical Circles which border on the Meridian, much swifter than those Stars which are more distant therefrom ; so these luminous Rays would seem to recede faster from East to West, as their Bases were nearer the Eye of the Spectator ; and *à contra*, slower as they were further off.

Nor are we to think it strange, if after so great a Quantity of lum'ous Vapour had been carried up into the Ether out of the Pores of the Earth, the Cause of its Effervescence at length abating, or perhaps the Matter thereof consumed ; these *Effluvia* should at length subside, and form those two bright *Laminae* which we have described, and whose Edges being turn'd to us were capable to emit so much Light that we might read by them. I choose to call them *Laminae*, because, without doubt, though they were but thin, they spread Horizontally over a large Tract of the Earth Surface. And whilst this luminous Matter dropt down from the upper Plate to the under, the many little white Columns were formed between them by its Descent, only visible for the Moment of their Fall. These by the Swiftness with which they vanished and their great Number, shewing themselves and disappearing without any order, exhibited a very odd Appearance ; those on the Right seeming sometimes to drive and push those on the left, and *vice versa*.

I have been obliged to omit several Particulars of less moment : But these are the principal Phenomena ; of whose Causes I should have more willingly and with more certainty given my Thoughts, if I had had the good luck to have seen the whole from Beginning to end ; and to have added my own Remarks to the Relations of others : and especially if we could by any means have come at the Distances thereof. If it shall by any be thought a hard Supposition that I assume the *Effluvia* of the Magnetical Matter for this purpose, which in certain Cases may themselves become luminous, or rather may sometimes carry with them out of the Bowels of the Earth a sort of Atoms proper to produce Light in the Ether. I answer that we are not as yet informed of any other Kinds of *Effluvia* of terrestrial Matter which may serve for our purpose, than those we have here considered, *viz.* the Magnetical Atoms, and those of Water highly rarified into Vapour. Nor do we find any thing like it in what we see of the Celestial Bodies, unless it be the *Effluvia* projected out of the Bodies of Comets to a vast Height, and which seem by a *Vis centrifuga* to fly with an incredible Swiftness the Centers both of the Sun and Comet, and to go off into Tails of a scarce conceivable Length. What may be the Constitution of these Cometical Vapours, we Inhabitants of the *Earth* can know but little, and only that they are evidently excited by the Heat of the Sun ; whereas this Meteor, if I may so call it, seldom is seen but in the polar Regions of the World, and that most commonly in the Winter Months. But whatever may be the Cause thereof, if this be not, I have followed the old Axiom of the Schools. *Entia non esse temere neque absque necessitate multiplicanda.*

Lastly I beg leave on this Occasion to mention what, near 25 Years since, I publish'd in No 95. of these *Transactions*, *viz.* That supposing the *Earth* to be concave,

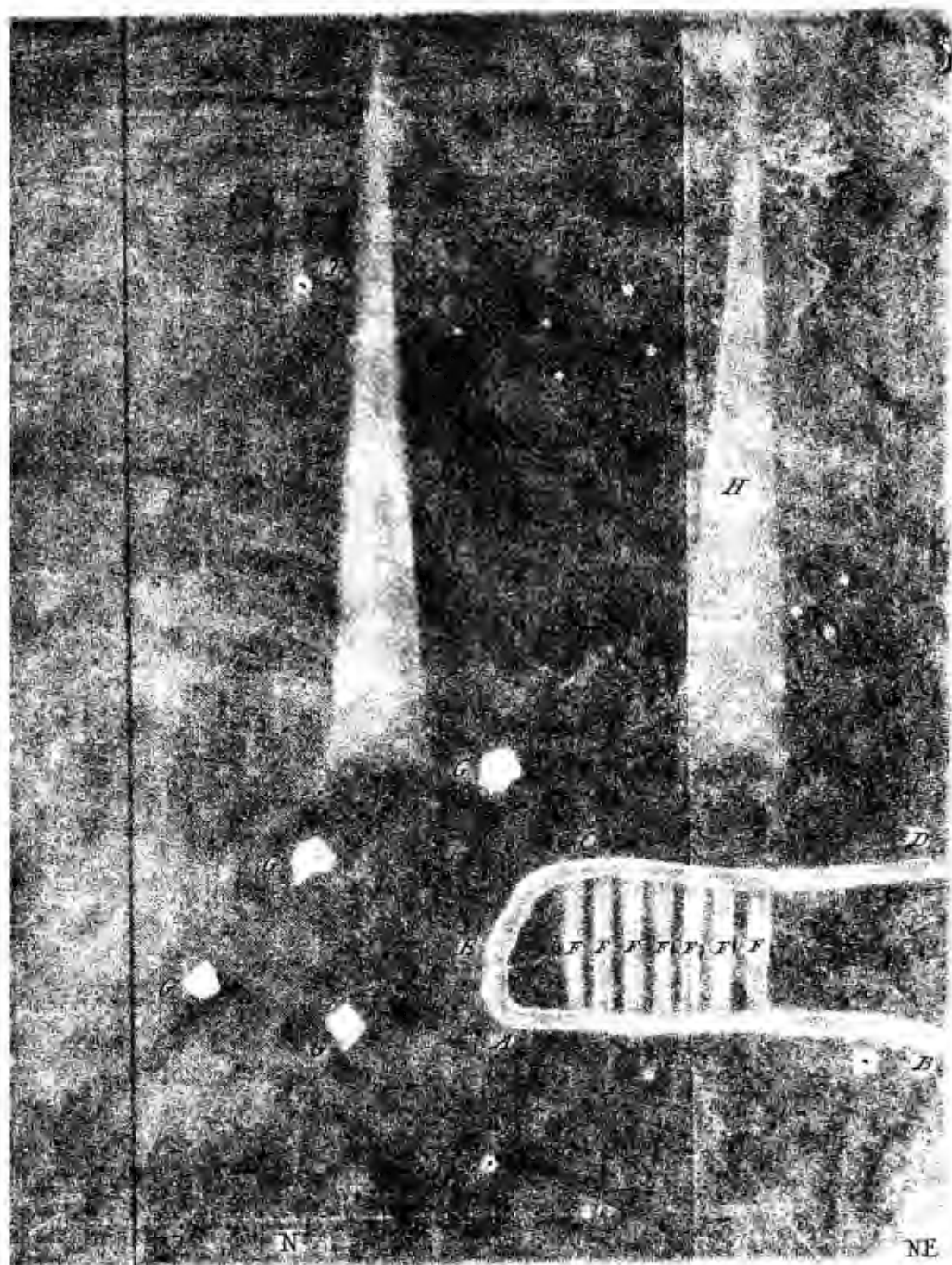
with a lesser Globe included, in order to make that inner Globe capable of being inhabited, there might not improbably be contained some luminous *Medium* between the Balls, so as to make a perpetual Day below. That very great Tracts of the Etherial Space are occupied by such a shining *Medium* is evident from the Instances given in the first Paper of this *Transaſtion*: And if ſuch a *Medium* ſhould be thus incloſed within us; what ſhould hinder but we may be allowed to ſuppoſe that ſome parts of this lucid Subſtance may, on very rare and extraordinary Occaſions, tranſude through and penetrate the *Cortex* of our *Earth*, and being got looſe may afford the Matter whereof this our *Meteor* conſiſts. This ſeems favoured by one conſiderable Circumſtance, *viz.* that the *Earth*, becauſe of its diurnal Rotation, being neceſſarily of the Figure of a Flat *Spheroid*, the thickneſs of the *Cortex*, in the *Polar* Parts of the Globe, is conſiderably leſs than towards the *Equator*; and therefore more likely to give Paſſage to theſe Vapours; whence a reaſon may be given why theſe Lights are always ſeen in the North. But I deſire to lay no more ſtreſs upon this Conceit than it will bear.

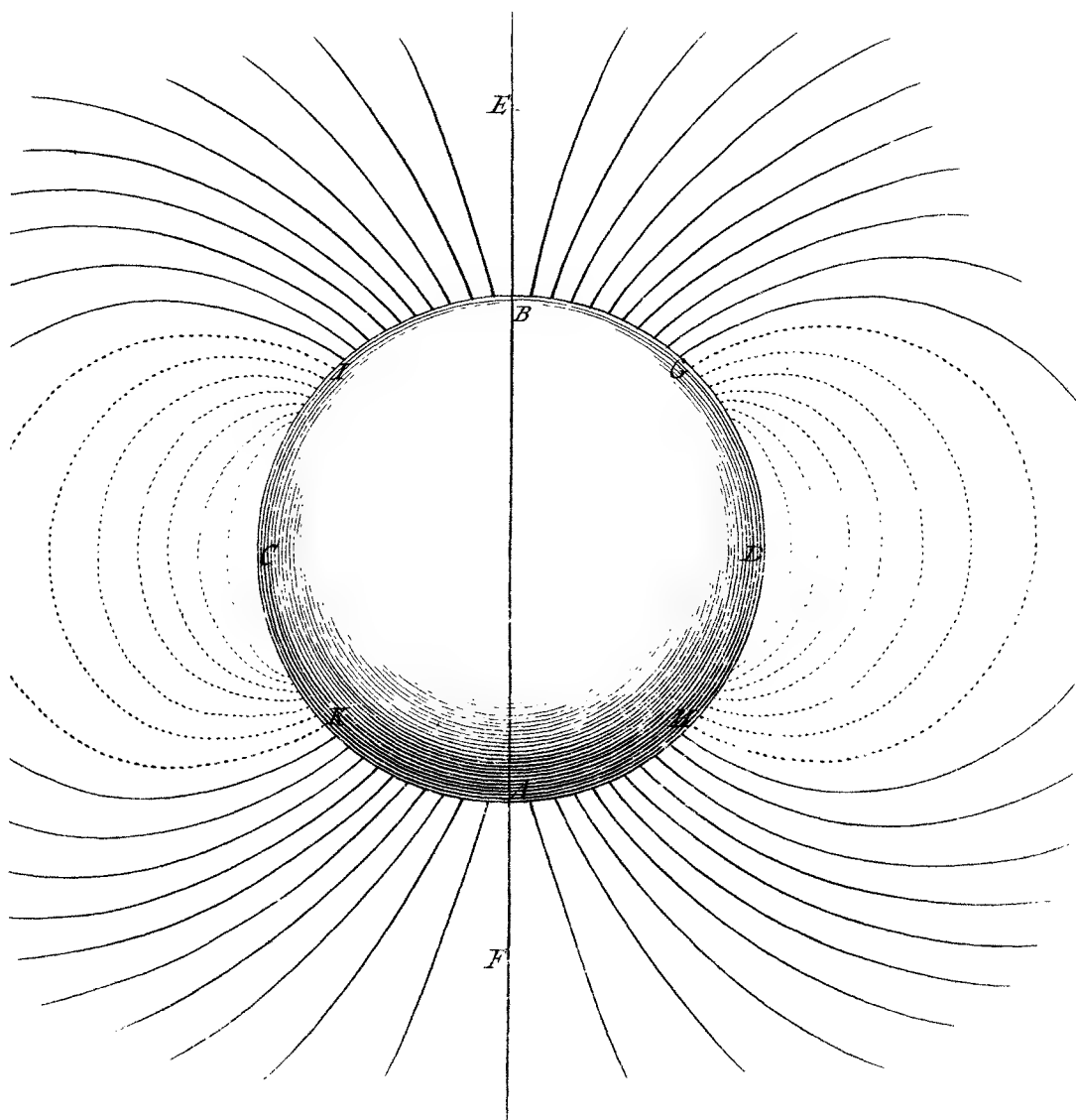
It having been noted that in the Years 1575 and 1580, wherein this Appearance was frequent, that it was ſeen not far from the Times of the two Equinoxes; it may be worth while for the Curious, to beſtow ſome Attention on the Heavens in the Months of *September* and *October* next; and in caſe it ſhould again happen, to endeavour to obſerve, by the Method I have here laid down, what may determine, with ſome degree of Exaſtneſs, the Diſtance and Height thereof; without which we can ſcarce come to any juſt Conclusion.

F I N I S.

*Errata.* No. 346. p. 383. l. 18. read 234. p. 408. l. 20.  
read, proceed, as at firſt.









1997-1998

# X

H



1

5

[illegible]

N

NE

# PHILOSOPHICAL TRANSACTIONS.

For the Months of *April, May and June, 1716.*

## The CONTENTS.

- I. **A** Description of the Phenomenon of the 6th of March last, as it was seen on the Ocean, near the Coast of Spain. With an Account of the return of the same sort of Appearance, on March 31, and April 1. and 2. following.
- II. An Account of some Experiments of Light and Colours; formerly made by Sir Isaac Newton, and mention'd in his Opticks, lately repeated before the Royal Society, by J. T. Desaguliers, F. R. S.
- III. A plain and easy Experiment to confirm Sir Isaac Newton's Doctrine of the different Refrangibility of the Rays of Light. By the same.
- IV. An Account of what appear'd on opening the big-belly'd Woman near Haman in Shropshire, who was suppos'd to have continued many Years with Child. Communicated by Dr. Hollings, M. D. from Shrewsbury.
- V. *Methodus singularis quâ Solis Parallaxis five distantia à Terra, ope Veneris intra Solem conspicienda, tuiò determinari poterit: proposita coram Regia Societate ab Edm. Halleio, J. U. D. ejusdem Societatis Secretario.*

I: *A description of the Phenomenon of March 6. last, as it was seen on the Ocean, near the Coast of Spain. With an Account of the return of the same sort of Appearance, on March 31. and April 1. and 2. following.*

IN our last, we endeavour'd to give the Publick as good an Account of the late surprizing *Meteor*, seen in the Heavens, on the sixth of *March* last, as could be gathered from the several Relations of very distant Spectators, which had then come to the *Royal Society's* Notice. And since then, we can only add thereto, that at *Paris*, the Light was so inconsiderable, that it was not regarded: But from a Letter to Mr. *Alexander Geekie*, Surgeon, dated on Board a Ship in *Nevis Road*, in *America*, April 19 1716. we have copied the following Passage. " On the sixth of *March*, at 9 a Clock " in the Evening, we being then in the Latitude of  $45^{\circ}.36'$ . " (off of the *N.W. Coast of Spain*). A clear Cloud appeared *East* of us, not far distant from our Zenith, which " afterwards darted it self forth into a number of Rays of " Light, every way like the Tail of a Comet, of such a " great Length, that it reach'd within a short way of the " Horizon. There likewise appear'd a Body of Light, " *N. N. E.* of us, and continued as Light almost as Day, till " after 12 a Clock. It appear'd at a good distance from us, " and darkned on a sudden.

Hence it should seem, that the Vapour which caused this Appearance, arose indifferently out of the deep Ocean Sea, as well as from the Land; by which we may conclude the great Subtily of the Matter thereof, since it could permeate so great a Quantity of Water, and yet retain its Velocity; which is a Circumstance deserving the further consideration of the Curious.

But since this, most of the same *Phænomena* have been repeated three several Nights successively, viz. On the last of *March*, and first and second of *April*. The best and fullest Description

tion of the two first, is, from a Letter of Dr. *Brook Taylor*, LL. D. and Secretary to the *Royal Society*, dated *April 2*, from *Cotterstock*, near *Oundle* in *Northampton-shire*, who thus describes them. "On *Saturday Night* last, and last Night, I saw Appearances of the same kind, with those of *March 6*. but not to compare for Extent and Strength to the other. They both began soon after Sun set, and continued till after 12, but how much longer I cannot tell. They were both about 10 or 15 degrees to the Westward of the *North*, and took up about 80 degrees of the *Horizon*; and the *Aurora* rose about 30 gr. high, with a dark Bottom, like what was seen in the First; and from whence there sprung out several Bodies of Light, which immediately run into Streams, ascending about 30, or at most 40 gr. high. There was no flashing nor waving Light, but in all other respects, these Lights were of the same kind with what we saw at *London*. Indeed in that last Night, there was one *Phænomenon* like the flashing Light, for a Body of Light about 15 or 20 degrees long, parallel to the *Horizon*, rose till it came about 6 degrees above the black Basis, and then sent up two strong Streams of Light about 40 gr. high, which at top dash'd against one another, and disappear'd."

At *London*, the first Night, *March 31*. It did not begin to radiate, till towards Mid-night, and was seen but by few curious Persons; the Beams not rising very high, and scarce appearing over the Houses, were little taken notice of: but by the Relation of those that saw it, it was much more considerable than the next Night following *Easter-day*, for it then sent out but few and very short Beams, mostly terminating in a sharp Point, and presently disappearing. Only it beginning to stream so soon as it became Dusky, it was very observable, that those Rays which arose out of the West end of the Luminous Arch, next the Sun, were enlightened by its Beams, and shew'd themselves much brighter than those which sprung up under the Pole, or to the Eastward thereof. And after Nine, till Mid-night, no more Beams arose; and the Luminous Arch with its black Basis, settled down very low in the Northern Horizon.

The same two Nights, by the Observation of Mr. *William Lingan*, the like Appearance was seen at *Dublin*, about the  
hours

hours of Nine or Ten ; at which time, in the former Night, it was near as Light as in a Moon-light Night. And from *France* we have an Account, that both those Nights, the same was seen at *Paris*, with much the same Circumstances as at *Dublin*. So that it seems this Meteor, though no ways comparable to that of the 6th of *March*. was seen not less than 150 Leagues, and probably much further.

The following Night, *April 2*. When it began to be dark, a Luminous Arch appear'd in the *North*, with a very narrow black Bottom under it, very low, and depress'd to the Horizon ; nor was it seen at, or about *London*, to project any pointed Rays as the former.

But what was most remarkable that Evening, was, what was seen at *London*, by that ingenious Gentleman *Martin Foulks*, Esq; R. S. S. about Nine that Night. He being in the open Air at that time, saw in an Instant, a bright Ray of very white Light, appear in the East, out of the pure Sky, then very serene and still ; it very much resembled the Tail of a Comet, and was about 20 gr. inclined from the Perpendicular to the Right, beginning about  $\gamma$  of *Bayer* in the *Corona Borea*, and terminating about the *Informis* by some call'd *Cor Caroli*. This having appear'd but a very short time, disappear'd at once, as in a Moment. When on a sudden, such another Beam was instantly produced, not exactly in the same place, but in the same Situation. Its lower end being about 20 gr. high, was terminated exactly between  $\kappa$  and  $\gamma$ , in the Right Hand and Arm of *Hercules*, and the Middle of it past over  $\sigma$  and  $\varsigma$  in the Girdle of *Bootes*, and thence proceeded Westwards, leaving *Cor Caroli* four or five degrees to the Northwards. After it had continued in this posture near 10 Minutes immoveable among the Stars, it began to move slowly towards the North : and the lower end passing over the Northern Edge of the *Crown*, and the Ray it self over *Cor Caroli*, it grew fainter, and vanished, having continued in all about 20 Minutes. This latter with some Interruptions was extended between *Cassiopeia* and *Pollux*, very far into the West. And about that time, the same, or such another Beam, was seen at *St. Asaph*, by Doctor *Stanley*, the Reverend Dean of that Church.

II. *An Account of some Experiments of Light and Colours, formerly made by Sir Isaac Newton, and mention'd in his Opticks, lately repeated before the Royal Society by J. T. Desaguliers, F. R. S.*

**T**HE manner of separating the primitive Colours of Light to such a Degree, that if any one of the separated Lights be taken apart, its Colour shall be found unchangeable, was not published before Sir I<sup>s</sup>. Newton's *Opticks* came abroad. For want of knowing how this was to be done, some Gentlemen of the English College at Liege, and Monsieur Mariotte in France, and some others took those for primitive Colours, which are made by immitting a Beam of the Sun's Light into a dark Room through a small round Hole, and refracting the Beam by a triangular Prism of Glass placed at the Hole. And by trying the Experiment in this manner, they found that the Colours thus made were capable of change, and thereupon reported that the Experiment did not succeed. And lately the Editor of the *Acta Eruditorum* for October 1713. pag. 447, desired that Sir I<sup>s</sup>. Newton would remove this Difficulty. *Objectiones, inquit, quas Viri docti tum in Gallia tum in Anglia contra illam [de Coloribus] Theoriam fecere, felicissime diluit Vir perspicacissimus Newtonus, quemadmodum ex Transactionibus Anglicanis N. 84, 85, 88, 96, 97, 121, 123, 128 abunde constat. Unde multi optant ut mentem suam aperire dignetur de difficultate ab ingeniosissimo Mariotto, rerum naturalium (dum viveret) scrutatore indefesso nec infelici, in Tractatu de Coloribus p. 207. & seq. contra eam mora. In distantia scilicet 25 circiter aut 30 pedum, charta exceptit radium solidum per exiguum foramen in cameram obscuram immissum,*

& per Prisma vitreum trigonum transmissum, coloremque violaceum spatium majus quam trium linearum occupantem per crenam duarum linearum trajectum, alio Prismate exceptit admodum oblique opposito : quo facto quandam ejus partem in Rubrum & Flavum transmutari observavit. Similiter luminis rubri partem in cœruleum & violaceum transmutari expertus est. Hac verò transmutatione admissa corrui Theoriam Newtonianam, ex Actis A. 1706. p. 60. & seq manifestum est. Assumpsit autem Mariottus distantiam 30 pedum, ne quis exciperet in minori distantia nondum factam esse plenariam radiorum heterogeneorum separationem. Nobis experimentum Mariotti tum demum videretur decisivum, si lumen cœruleum integrum in aliud mutatum fuisset. Thus far the Editor of the Acta. In answer to which it is to be observed that the Red and Yellow which came out of the Violet, and the Blew and Violet which came out of the Red, might proceed from the very bright Light of the Sky next encompassing the Sun, and that several sorts of Rays which come from several Parts of the Sun's Body are intermixt in all parts of the coloured Spectrum which falls upon a Paper at any Distance from the Prism. In this manner of trial, for making the Experiment succeed, the Light of the bright Clouds, immediately surrounding the Sun, should be intercepted by an opaque Skreen placed in the open Air without, at the distance of Ten or Twenty Foot from the Hole through which the Sun shines into the dark Room. And in the Skreen there should be a small Hole for the Sun to shine through. The Hole may be either round or oblong, and not above one eighth or one tenth Part of an Inch broad ; so that the Skreen may intercept not only the bright Light of the Clouds next encompassing the Sun's Body, but also the greatest Part of the Sun's Light. For thereby the Colours will become less mixed. The Beam of Light which passes through this Hole must afterwards pass through the other Hole into the dark Room, and the Prism must be placed parallel to the oblong Hole in the Skreen

*Screen, and the refracting Angle thereof be sixty Degrees or above. In this manner the Experiment may be tried with Success, but the Trial will be less troublesome if it be made in such a manner as is described in the fourth Proposition of the first Book of Sir Iſ. Newton's Opticks.*

*Sir Iſaac Newton therefore, upon reading what has been cited out of the Acta Eruditorum, desired Mr. Deſaguliers to try the Experiment in the manner described in the said Proposition; and he tried it accordingly with Success before several Gentlemen of the Royal Society, and afterwards before Monsieur Monmort and others of the Royal Academy of Sciences; and still shews it to those who desire to see it. How this and other concomitant Experiments were tried and succeeded, is described as follows.*

## EXPERIMENT I.

Having sew'd together end-wise two Pieces of Ribbon four Inches long each, the one blew and the other red, whose common Breadth was  $\frac{3}{4}$  of an Inch; I caus'd it to be held in such manner, that the Light which fell from the Clouds thro' the Window was so reflected, that the Angle made by the Rays of Light, which came in at the Middle of the Window, with the Plane of the Ribbon produced, was equal to the Angle made by a Line drawn from the Ribbon to my Eye and the said Plain of the Ribbon. My Eye was plac'd as far behind the Ribbon as the Window was before it, the Distance from which to me was about 12 Feet. Then looking thro' a Prism at the Ribbon, it appear'd broken asunder in the Place where the blew and red Half join'd. If the Prism was held with the refracting Angle downwards (or laid with one of its Planes flat upon the Nose) the blew Half of the Ribbon appear'd to be carried down lower than the red, as at *B, R* in *Fig. 1.* but if the refracting Angle of the Prism was turn'd up-

Y y 2

wards



wards (as when the Prism has one of its Planes laid flat to the Forehead) then the blew Half of the Ribbon was lifted up, as at *C* *p*.

The Prism was of white Glass, having every Angle of 60 Degrees: but when instead of it, one of a greenish sort of Glass, such as Object Glasses of Telescopes are made of, was used, having the refracting Angle which I look'd thro' of about 48 Degrees; the same Phænomenon was more distinct, this Glass having no Veins, but the Red and Blue were nearer to a streight Line: in such manner that if *A* represent the Ribbon seen through the first Prism, *B* will represent the Ribbon seen thro' the second Prism. *Fig. 2.* If the refracting Angle of the last Prism had been as great as that of the first, the Light being transmitted thro' too great a Body of greenish Glass, the Phænomenon would not have succeeded so well.

The blue Ribbon being somewhat too pale, and the red a little dull; I repeated the Experiment with a Skeen of blue, and one of red Worsted join'd together in the Middle as the Ribbons were before; and, the Colours of both being very intense, the Experiment succeeded better with both Prisms. All that were present trying the Experiment found it to succeed, and that every Circumstance answer'd to the Account given in *Prop. 1. Theor. 1. Book 1.* of Sir Isaac Newton's *Optics*, as far as the Directions there given were followed. So that it appear'd that the Blue being carried lower than the Red in the first case, and lifted higher in the second, was owing to the greater Refraction of the blue Ray: for tho' each Part of the Ribbon or Worsted reflected all manner of Rays, yet the Phænomenon was very apparent; as also that the blue Ribbon or Worsted reflected the blue Rays more copiously than the red Rays, and that the red Ribbon or Worsted reflected the red Rays more than the blue ones, because the Red of the blue Half seen thro' the Prism was less intense than

than that of the red Half, and the Blue or Purple of the red Half seen thro' the Prism was less intense than that of the blue Half.

*N. B.* If the Ribbon or Worsted is laid upon any enlightened Body, the Phænomenon will not succeed so well; the Colours of the Body seen thro' the Prism mixing with those of the Ribbon or Worsted. Even a black Body will not do, if Light falls upon it; but there must be a black Cloath behind, in such manner that no Light falling upon it can be reflected so as to disturb the Phænomenon. And if a short-sighted Person looks through the Prism, a concave Lens between his Eye and the Prism will render the Phænomenon more distinct than it wou'd otherwise be.

## EXPERIMENT II.

Some Days after, the Sun shining, I made two Holes *H, h*, in the Window Shut *S s*, of a darkned Room; thro' which letting the Sun's Beams pass, by means of two Prisms *A, B*, (one near each Hole) I open'd the Rays coming from the Sun into the two colour'd *Spectra*  $\alpha, \beta$ , where the following Colours were very distinct, *viz.* Red, Orange, Yellow, Green, Blue, Purple and Violet. Now the Reason of their being more distinct than ordinary, was, that the Prisms which I made use of were made of the greenish Glass mentioned before; which is very free from those Veins by which the Colours are too much thrown into one another, by the best white Prisms of the common sort.

The foremention'd colour'd *Spectra* being thrown into the Room, to the Distance of about 20 Feet from the Window where the Sun's Light came in, I caus'd a Piece of white Paper  $\pi$ ,  $\frac{3}{4}$  Inch broad and 5 Inches long, to be held within the refracted Rays, (at the Distance of 10 Feet from the Windows,) which produc'd these Colours in such manner, that by turning the Prisms round their  
 Axes

Axes, I cou'd make the red Ray of the *Spectrum*, made by the one Prism fall upon one half of the Paper, and the purple Ray of the *Spectrum* made by the other Prism fall upon the other Half; for the *Spectra* were both vertical, the Lines which terminated the long Sides of them towards each other just touching, as appears in *Fig. 3.* Then at the Distance of 9 Foot, looking thro' the Prism *C* at the Paper thus colour'd, the red Half appear'd very much separated from the Purple, the one seeming lifted up from the other; the Red or the Purple appearing the highest, according as the refracting Angle of the Prism was either held upwards or downwards. The Phænomenon is much more distinct this way than any other; for the Paper not only seems divided into two, when it is coloured by a red and a purple Ray, but also by a Red and Blue, (*Fig. 4.*) by a red and a green Ray. (*Fig. 5.*) or indeed by any two Colours that are different, how near soever their Places in the *Spectra* be to each other. The Halves of the Paper appear, when view'd thro' the Prism, to be farther from each other, when the Paper is ting'd with such Colours as are farther from each other in the Series of Colours in the *Spectrum*: and nearest, tho' still divided, when neighbouring Colours fall upon the Paper, as Yellow and Green, or a light and a deep Green. But the Paper appears no way divided, when colour'd with the Red of the two *Spectra*, (*Fig. 6.*) if those Reds are equally intense: and so of the other Colours.

### EXPERIMENT III.

I held a Lens of about 3 Foot Radius at the Distance of Six Feet from the oblong Paper (on which a red and purple Ray falling, made it look half Red and half Purple) and I projected the Image of the said colour'd Paper at the Distance of about Six Foot on the other Side of the Lens,  
on

on a white Sheet of Paper ; where it was observeable, that when the red Half was distinctly painted on the white Paper (which was known by the Edges of the Image being regularly terminated) then the blue Half of the Image was confus'd : but if the white Paper was brought about two inches nearer to the Lens, the Image of the blue Half became distinct, and that of the red Half confus'd.

I try'd the Experiment with a Paper colour'd half red and half blue the red with Carminé and the blew with Smalt, making the Candle to enlighten the Paper (the Room being otherwise dark) and the Experiment succeeded in the same manner. The Experiment thus made is the same that Sir *Isaac Newton* gives an Account of, *Book 1. Part. 1. Theor. 1. of his Optics.* Only it is to be observ'd that when the oblong Paper is coloured with red and blue from the Prisms, the focal place, where the red part of the Image is distinct, is more distant from the place where the blue part of the Image is distinct, than when the Paper is colour'd with the Painter's Powders, and much more vivid.

The 7<sup>th</sup> Figure shews the Projection of the Paper ring'd with the Rays ; and *Fig. 8.* the Projection of it when painted : where a black Thread is wrapp'd round the red and the blue part, that the Distinctness of the Image of the Thread may shew when the red or when the blue part of the Image of the Paper is most distinct.

*N. B.* When the Candle enlightens the painted Paper, set an opaque Body as *B* between the Candle and Lens ; lest the Image of the Candle being also projected should disturb the Experiment.

#### EXPERIMENT IV.

Having made an Hole of  $\frac{1}{4}$  Inch Diameter in the Window-Shut of the darkned Room, I suffer'd a Sun-Beam to  
come

come into the Room, which I intercepted with a Prism at the Distance of 5 Inches from the Hole; and after its Refraction in passing thro' the Prism, I receiv'd it upon a Sheet of white Paper, where it was colour'd, making an oblong Image of the Sun or *Spectrum* of about 9 Inches in length and 2 in breadth, which Breadth was nearly equal to the Diameter of the round Image of the Sun received upon a Paper at the same Distance from the Hole, which here was 18 Foot. Or if the Sun be too high, a Looking-Glass being put in the room of the Prism will throw a white round *Spectrum* upon the Paper, which held at the said Distance of 18 Foot, will have its Diameter equal to the Breadth of the colour'd *Spectrum*.

The Colours of the *Spectrum* were these; Red, Orange, Yellow, Green Blue, Purple and Violet, tho' the Violet was so faint in this as to be scarce perceivable. See Fig. 9.

N. B. The Axis of the Prism in this, and all the other Experiments hereafter mention'd must be perpendicular to the Ray that falls on it; and the Plane into which the Ray enters must be held in such a Position, that the Angle which such a Ray makes with that Plane when it enters, may be equal to the Angle made by the middle Line of those Rays which emerge after Refraction, on the other Side of the refracting Angle of the Prism, with the Plane out of which they emerge. That is  $\angle BDG = \angle AEH$

If the Plane  $AC$ , on which the Sun-Beam falls, be turned nearer to a perpendicular to the Sun Beam than before, the *Spectrum* will be much longer: if it be more inclin'd to the said Beam, the *Spectrum* will be shorter, and in both Cases less distinct. See the *Spectrum*  $DE$  and the *Spectrum*  $de$  in Fig. 10. and 11. where  $H, h$ , represents the Hole in the Window Shut in each Case;  $AC, ac$  the Plane of the Prism on which the Rays enter;  $BC, bc$  that out of which they emerge;  $P, p$  the perpendicular, and  $C, c$  the refracting Angle. If

If the Plane  $AC$  be still more oblique to  $HE$ , all the Light will be reflected, and there will be no colour'd Image or *Spectrum* made by Refraction at all. *Fig. 12.*

But if it be held so as to be more nearly perpendicular to the Sun Beam than in *Fig. 10.* the whole Beam will indeed enter the Prism; but meeting with  $BC$  the lower Surface of the Prism, or rather the Surface of the Air contiguous to it, some of the Light will by the Plane  $BC$  be reflected to  $de$ , passing almost perpendicularly thro'  $AE$ ; and the rest will emerge thro'  $BC$ , and by Refraction make the imperfect *Spectrum DE*. See *Fig. 10.*

If the Sun-Beam enter  $AC$  perpendicularly and in the middle of it, the Light will be all reflected as in *Fig. 13.* some of it by the Plane  $BC$  to  $R$ , and the rest by the Plane  $AB$  to  $p$ . But if the Beam fall nearer to  $A$  (still perpendicularly) it will all be reflected by the Plane  $AB$ ; if nearer to  $B$ , it will be all reflected by the Plane  $BC$ .

In order therefore to have the colour'd *Spectrum* as it ought to be, care must be taken that the emerging coloured Light may make the same Angle with the Plane  $BC$ , as the immerging Light does with the Plane  $AC$ ; that is, the Angle  $AEH$  must be equal to  $BDG$ , as was said before, *Fig. 9.* which may also be seen on the enlightened Dust in the Air. But the best way is to turn the Prism on its Axis, and at the same time look at the colour'd *Spectrum*, which will rise and fall and become longer or shorter as you turn the Prism; and between the Ascent and Descent of the Image, it will appear stationary: there stop the Prism, and the Reflection will be such as is required for all the Experiments hereafter mention'd.

In order to have the Prism move freely on its Axis, and stop any where, I fix'd each End of it into a triangular Collar of Tin, from the End of which came a Wire, which was the Axis of the Prism produc'd; and so I laid it on two wooden Pillars, with a Notch on the Top to receive

the Wires, and fix'd it to a small Board just broad enough to stand fast. See *Fig. 14.*

### EXPERIMENT V.

I took the Prism *CD*, and thro' it look'd at the colour'd *Spectrum RP*, which appear'd then round and white as at *S* just as if it had been the Sun's Light received on a Paper from the Hole *H*, and seen with the naked Eye. In this case the Prism *CD* must be held *in directum* with *AB*, and the refracting Angles in the two Prisms must be equal. This *Spectrum* appearing white but just in one Point, is not so readily found; but the best way is to look thro' the same Prism *AB* which makes the *Spectrum*, which may easily be done if it be pretty long, and then *KI* will be seen white and round, and as at *S*, as if coming directly from *H*. See *Fig. 15.*

### EXPERIMENT VI.

I held a broad *Lens LL*, ground to a Radius of  $2\frac{1}{2}$  Feet, in such manner that the whole colour'd *Spectrum* fell upon it; and after Refraction all the Colours appear'd to converge, if receiv'd on a Paper at *pp*; but when the Paper was held in the Focus at *F* in the position  $\pi F \pi$ , the *Spectrum* was round and perfectly white by the Union of all the colour'd Rays. If the Paper was held at  $\Pi \Pi$ , the Colours appear'd to diverge from each other, but then the Red was uppermost, which before us'd to be the lowest, and so on in an inverted Order.

I try'd the same Experiment with a *Lens* of one Foot Radius, with one of 9 inches, and with another of 7, and the Success was the same. See the 16th Figure, where the *R, O, T, G, B, P, V*, exprefs the Colours.

N. B.

*N. B.* Care must be taken that the very end of the Red, and the Extremity of the Violet be taken in by the *Lens*; otherwise the *Spectrum* will not be perfectly white at the Glass's Focus.

There is no fix'd Distance of the Prism from the Lens, but it ought to be brought so near the Prism that the two Ends of the *Spectrum* may fall nearer the Axis of the Lens than the Edges of the Lens; because there the Refraction is not so regular.

Behind the Lens *L*, which made the Colours converge into White at the distinct Base or Focus *F*, I plac'd the Lens *l*. which made the White be at *f* the distinct Base of the two Glasses combin'd; and the Experiment succeeded as before. Fig. 17.

When the Paper was held in the Focus of the Lens, so as to receive the white Image of the colour'd *Spectrum* projected by the Lens; if with a Card I intercepted the red Ray, the White appear'd ting'd with Purple, and if I intercepted the Violet or purple Ray, or both, the White appear'd ting'd with Red; and if the Red was intercepted at the same time, the *Spectrum* appear'd to be a Mixture of Yellow, Green and Blue. If any single Colour was suffer'd to fall upon the Lens, the rest being intercepted, that Colour wou'd continue the same; only it wou'd be more intense in the Focus of the Lens.

## EXPERIMENT VII.

I took a Board (*Fig. 18.*) *q h's* which stood reclining on a Prop *t*, having an Hole of a Quarter of an Inch Diameter at *b*, and behind it a Prism *B* supported on two Props, as above-mention'd, so as to turn easily about its Axis; and having set this Board on the Ground with the Prism behind it at *B*; by turning the Prism *AC* about its Axis, I first made the red Ray of the colour'd *Spectrum*

Z z z 2

pass



pass thro' the Hole *h*, and fall obliquely upon the second Prism *B*. This Ray after its Refraction in passing thro' the second Prism, was carried up to the Ceiling of the Room at the place mark'd *R*: then I made the purple Ray fall upon the Board, and pass thro' the Hole *h*, as the Red had done before; and after Refraction thro' the Prism *B* it was carried up to the Ceiling at *P*. And the green Ray being afterwards made to pass the second Prism in the same manner, went up to *G*: and so of all the intermediate Rays, which were by this second Refraction thrown to the intermediate places on the Ceiling between *R* and *P*.

Care is to be taken that the second Prism be plac'd oblique to the Rays which come thro' the Hole *h*, least they be reflected, as they wou'd be, if the Board being in the Position *Q S*, and the second Prism in the Position *L N M*, the Ray from the first Prism be *p h*; for then it will be reflected upwards to *σ* instead of being refracted (*Fig. 19.*). Neither must the Plane of Immersion be too oblique, least the Incident Ray be reflected downwards by it, as the Ray *R h* is by the Prism *B* thrown to *E*, in *Fig. 20.* Several have confess'd to me that they at first us'd to fail in this Experiment, for want of setting the second Prism in a due Inclination.

Tho' the Colours by the second Refraction on the Ceiling appear'd unchang'd, when seen by the naked Eye, yet if view'd thro' a Prism, they afforded new Colours (except some part of the Red, and some part of the Violet) which was owing to their not being fully separated; for which reason I made the following Experiment, to prove that if the Colours be well separated, they are truly homogeneous and unchangeable.

*N B.* When the Prisms are good, and no Clouds are near the Sun, the Extremity of the Red or Violet will afford unmix'd Colours in this Experiment; otherwise not.

## EXPERIMENT VIII.

Having made a Hole in the Window-Shut 2 Inches wide (*Fig. 21.*) I applied to it a Tin Plate, which sliding up and down hid all this Hole in the Wood, and only transmitted a small Beam thro' its own Hole *H*, whose Diameter was  $= \frac{1}{16}$  Inch. This Beam, by means of the Looking Glass *L*, plac'd on the Board of the Window *XW*, I reflected horizontally to the other end of the Room. But to correct the Irregularity of the Reflection of the Looking-Glass, I made use of the Frame of Past-Board *Pp*, which had an Hole in it *h* of  $\frac{1}{16}$  Inch likewise: and placing it at *Pp* I suffer'd some of the reflected Beams to pass thro' it, so as to fall upon the Lens *FE* (convex on both Sides, and ground to a Radius of  $4\frac{1}{2}$  Feet) at the Distance of 9 Feet, so that the Image of the Hole *h* was projected to *f* on the other Side of the Glass, at the Distance of 9 Feet more. Just behind the Lens, which by a Screw in the Stand *S* might be rais'd or let down, so as always to receive the Beam along its Axis, I plac'd a Prism *A* (upright on one of its Ends and easily moveable about its Axis, by reason of its Wire turning freely in an Hole in the solid piece of Wood *T*, which stood on another Stand behind the Lens) as near as I cou'd to the Lens *EF*, so that the Image of *h* instead of being round, white, and projected to *f*, was cast sidewise on a white Paper stretch'd on a Frame, and appear'd colour'd, and 30 or 40 times its Breadth, as at *MN*. The Colours in this Case were very vivid and well separated. only the Violet had some pale Light darting from its End, upon account of some Veins in the Prism *A*, and the Light not coming directly from the Sun, but reflected; which ought not to have been, if the Sun had been low enough to have thrown the Rays a good way into the Room without the Help of a Looking Glass.

To

To shew that the Colours in this *Spectrum* were simple and homogeneal Lights, I made the following Experiments.

### EXPERIMENT IX.

Having made an Hole *h* in the Paper which receiv'd the colour'd *Spectrum*, I suffer'd the red Light to pass; which being refracted by a second Prism, fell upon another Paper at *T*, where it appear'd still Red whether seen with the naked Eye or Prisms of different refracting Angles. To the Eye which saw it thro' the Prism *V*, it appear'd indeed lower as at *t*, but red, round and unchang'd. I made the Experiment upon all the Colours, which by this means appear'd to be simple and homogeneal. See *Fig. 22*. Where the same Letters denote the Lens, Prism and first Paper.

Thro' the same Lens and Prism the *Spectrum* was made to fall on a Book; then thro' the Prism *F* it appear'd unchang'd; and the Letters in the Book which cross'd the *Spectrum*, were as distinct as when seen with the naked Eye See *Fig. 23*.

*N B.* The Axis of the Prism *F* ought to be perpendicular to the long Axis of the *Spectrum's m* thrown on the Book, which will appear as at  $\sigma\mu$ ; and the Prism in the Position represented at *F*, with its flat Side towards the Nose: for that is the most convenient Position for looking at the *Spectrum* in these Experiments.

I suffer'd the purple Ray only to pass thro' the Hole *h* and fall upon a Book at *P*, the Letters of which appear'd at  $\pi$ , and were as distinct thro' the Prism *Q* as when seen with the naked Eye: and I had the same Success with all the other Rays. See *Fig. 24*.

But if a Sun-Beam as *r* comes thro' the Hole *H* directly upon the Book at *W*, an Eye looking at it thro' a Prism  
at

at *X* will see this Beam at *T* oblong and colour'd, and the Letters on which it falls, confus'd. See *Fig. 24.*

*N. B.* The Lens ought to be very good, without Veins or Blebs, and ground to no less a Radius than I mention'd in the Experiment; tho' a Radius of a Foot or two longer is not amiss. The Prism ought to be of the same Glass as the Object-Glasses of Telescopes, the white Glass, of which Prisms are usually made, being commonly full of Veins. And the Room in these last Experiments ought to be very dark.

A few Days after, having got very good Prisms made for the purpose of the above mention'd Glass, I made all the Experiments over again before several Members of the *Royal Society* with better Success; and had the *Spectrums* very regularly terminated, without any pale Light darting from the Ends of it.

*For a further Account of Experiments to this purpose, see Sir Isaac Newton's Opticks. B. 1. Part. 1. to which I might have refer'd the Reader altogether; but that I was willing to be particular in mentioning such things as ought to be avoided in making the Experiments above-mention'd; some Gentlemen abroad having complained that they had not found the Experiments answer, for want of sufficient Directions in Sir Isaac Newton's Opticks; tho' I had no other Directions than what I found there.*



III. *A plain and easy Experiment to confirm Sir Isaac Newton's Doctrine of the different Refrangibility of the Rays of Light. By the same.*

**A**FTER the *Experimentum Crucis* made by two Prisms, I shou'd not give the following Experiment, but that it is so easy to be made, that by it those who want the *Apparatus* (or are unwilling to be at the pains) to make the *Experimentum Crucis*, may at any time satisfy themselves of the Truth of the fore-mention'd Doctrine.

Let the Candle *A* be set before the Bar of a Chimney Looking-Glass, such as is represented by *HH* (*Fig. 25*) which is a Piece of Looking-Glass Plate consisting of four Planes, seen in the Section of it  $\alpha f d \beta$ , viz.  $d \beta$  which is quick-silver'd behind,  $f \alpha$  a Plane parallel to it,  $f d$  one of the Side-planes bezell'd towards  $d \beta$ , or inclin'd to it in an Angle of about 40 Degrees (tho' from 30 to 40 will do, but the greater the Angle the better, if it does not exceed  $45^\circ$ .)  $\alpha \beta$  the other Side-Plane inclin'd in the same Angle to  $\beta d$ .

The Rays of the Candle which come from *A* to  $\gamma$  fall obliquely on the Plane  $\alpha \beta$ , so that instead of going on to *a*, they are by Refraction made to incline more towards the Perpendicular  $p p$ , namely to go on in the Line  $\gamma c$ , and then are reflected from the Point *c* on the quick-silver'd Surface, in the Direction  $c x$ , so as to make the Angle  $x c d = \gamma c \beta$ . Now as the Rays which wou'd go to *x*, if not refracted, emerge obliquely from the Plane  $\alpha \beta$ , they leave the Direction  $c x$ , and decline from the Perpendicular  $\pi \pi$ , and, being differently refracted, open into four differently colour'd Rays; viz. *b R* a red Ray, *t O* a Ray made

made up of Orange and Yellow; *b G B* a Ray made up of Green and Blue or a Sea-Green, and *b P* a purple Ray.

If from the place *E e* you look full upon the Point *b*, the *Spectrum* or Image of the Candle at *b* will appear double, but not mix'd; that is, there will appear a Sea-green Spot and a red Spot, as it were, one upon another; but not so as to produce a mix'd or intermediate Colour. Then if the right Eye or Eye at *E* be shut, there will appear only a green Spot to the Eye at *e*; if the Eye at *e* be shut, the Eye at *E* will see only a red Spot.

If you come nearer to *b*, so that the Eyes at  $\varepsilon 1$ ,  $\varepsilon 2$  receive the most and the least refrangible Rays, there will be a double *Spectrum*, viz. a red and a purple one just touching, or upon one another: and the Phænomenon will answer as before. (*Fig. 25*).

If keeping both Eyes open, you direct their Axes towards *O* a Point nearer than the usual place of the compound *Spectrum S*, (*Fig. 26*.) which Point is in a Line from the Nose *N* to the Point *S*; or in other Words, if you look full at *O*, or at the End of your Finger held in *O*, the red and the blue (or purple Spot) will appear to be divided from each other after the manner represented at *p r* (in *Fig. 27*) where the Red will appear to be on the Right-hand, and the Blue on the Left.

To make plain what is meant by *seeing* the *Spectra p* and *r* whilst we look full at *O*, I beg leave to explain the Distinction between *looking* and *seeing*; that I may the better shew how this Phænomenon proves that the Sensation of different Colours is caus'd by Rays differently refracted.

### I. Definition.

The *Optic Axis* is a Line which going thro' the Center of the Convexity of all the Coats and Humours of the

A a a a

Eye

Eye, falls upon the Middle of the *Retina*, as  $\alpha \alpha$  or  $A a$  *Fig. 28.*

## II. Definition.

To *look* at any Point, is to turn both Eyes towards it in such manner, that the *Optic Axes* making an Angle at the said Point as  $a$ , the Rays from  $a$  may have the *Optic Axis* for their Axis, and (by their Convergence upon the *Retina* after Refraction in the Eye) may paint the Image of the said Point upon the Middle of the *Retina* of each Eye, where the Optic Axis in each Eye falls.

## III. Definition.

To *see* without *looking*, is to direct the Optic Axes to some other place than to the Point which is then seen ; and in such a case, the Image of the Point seen will be projected upon a part of the *Retina* of each Eye, where the Optic Axis does not fall, namely either nearer to the Nose  $N$  as in (*Fig. 26.*) at the Points of the *Retina* mark'd  $nn$ ; or farther from the Nose than the Middle of the *Retina*, as at  $oo$  in *Fig. 29.*

Whatever is *seen*, by being *look'd* at with both Eyes, always appears single, by reason of the Communication between the Middle of the *Retina* in one Eye, and the Middle of the *Retina* of the other : there being no such Communication between any other part of the *Retina* in one Eye, and the Correspondent part of the *Retina* in the other, when these correspondent parts are equally distant from the Nose.

*There is indeed a Communication between the Nervous Fibres on the Right-side of the Retina of one Eye, and the nervous Fibres on the Right-side of the Retina of the other Eye, and so of those on the Left : but no single Object can be so painted in each Eye, as to have its Image on the Right or Left Part of*  
*one*



one Retina that communicates with the Right or Left part of the other, of the same bigness and at the same time as in the other; because in whatever Position the Object is, it must be nearer to one Eye than to the other, except it be just in a Line from the Nose betwixt the two Eyes streight forward.

Hence it is that if there be two Candles set before any one, the First at the Distance of one Foot, and the Second at the Distance of two Feet, from the Eyes; he that looks at the second Candle at *B* will see it single, but see the first Candle or the Candle *A* double; one Appearance being in the Line *AD*  $\gamma$ , the other in *o A E*, because it paints it self upon *o o* in the Retina of each Eye, which Points are not the middle Points, but farther from the Nose than the middles *m m*.

So if *B* be the first Candle, and *C* the second, he that looks at *B* will see *C* double, because it is painted in the Retina at the Points *nn* nearer the Nose than *m m*; and so will appear to be in the same Position as *p r*. in Fig. 27.

If  $\gamma$   $\rho$  be two Candles so disposed, Fig. 30. that by the Interposition of a perforated Board *FF*,  $\gamma$  can paint it self only in the Eye *R*, and  $\rho$  in the Eye *L*. Upon making the Optic Axes meet at *B* and to tend towards  $\rho$  and  $\gamma$ ,  $\rho$  and  $\gamma$  will each paint an Image on the Middle of the Retina of each Eye, by crossing their Rays at *B*: and thus the two Candles will appear to be but One, or rather to be in one Place, upon the account of the Communication of the Middle of each Retina. But if instead of the Candles,  $\rho$  be a piece of red Silk, and  $\gamma$  a piece of green Silk, the same Position of the Eyes will make an Image at *B*, appearing like a red and green Spot together without a Mixture of the Colours. If  $\rho$  be a red hot Iron, and  $\gamma$  a Candle of Sulphur, the Phænomenon will be more distinct. If the Optic Axes be turn'd directly towards  $\gamma$  and  $\rho$ , as if there was no Board *FF* in the way, there will appear two

Holes in the Board, the one having the red hot Iron in it, the other the Candle.

Now if, of the refracted Rays of the Candle in the first Case (*Fig. 25.*) those which diverge from each other, so as to fall into each Eye, cause the same Sensations respectively, as the Rays which come from a red hot Iron and those which come from a blue Candle; it is evident that the Candle in the first case affords red-making and blue-making Rays after Refraction, and that those Rays are differently refrangible; the red *b R* (*Fig. 25.*) the least refrangible, as declining less from the Perpendicular  $\omega \omega$ ; and the Purple as *b P* declining most from the said Perpendicular.

The same will (*ceteris paribus*) be found true in the intermediate Rays; and to be certain that the Experiment is as I have related it, the Planes *α f* and *f d* of the Barr may be covered with Paper.

---

IV. *An Account of what appear'd on opening the big-belly'd Woman near Haman in Shropshire, who was suppos'd to have continued many Years with Child. Communicated by Dr. Hollings M.D. from Shrewsbury.*

A Marry'd Woman, near *Haman* about Three Miles from *Shrewsbury*, about the 40<sup>th</sup> Year of her Age, had then first the common Reasons to believe she was with Child: at the Time of her Account she had the usual Signs of Labour, and a good Midwife, tho' mistaken, assur'd her it was so, but that the Child was so big she could not be delivered without bringing it away in pieces. She not submitting to that, her Pains were soon off, and she continued without any other Disorders Nine Months longer, when

when she had again the Signs of Labour; and the same Midwife assur'd her as before, and she persisting in her former Resolution, her Pains, after a Day or two went off. Soon after her Belly swell'd to a surprizing Size, by which she got Subsistence for her Family by being seen as a Shew. I saw her first above twenty Years since, when her Belly was almost even with her Chin, the Weight of it so great, that she was oblig'd to support it with a Stool. She could not stand without the help of a Rope from the Cieling, which assisted her in changing her Posture of sitting. She slept commonly with her Arms folded on her Belly, and her Head rested between them. She had no swelling in her Legs: every other Part emaciated as usual in the like Cases. Thus this poor Creature liv'd without any other considerable Complaint above Thirty Years, the most remarkable Circumstance, I think, in her Case. She died in *May* 1715, when this appear'd to be an *Ascites*.

I need not mention the State the common Teguments must necessarily be in from so great a Distention, which had distorted many of her Ribs, and forc'd the Diaphragm so high, that it was surprizing to find her breathing could be so long continu'd. The Water was all contain'd in the Duplication of the *Peritoneum*, 13 Gallons besides a Quart that was spilt: it was saltish, with some little fat upon it, and towards the latter Running ting'd with Blood as usual. There was not any Water in the Cavity of the *Abdomen*, except what was contain'd in a kind of Bladder of the Shape I have sent, *Fig 31*. which lay a-cross the *Fundus Uteri*. This was divided by a Cartilaginous Substance into two Cavities; in one there was a Pint and a half, in the other three Parts of a Pint of Water. I believe it was this (I know not how) impos'd on the Midwife. The *Uterus* was of the natural Size without any Alteration, except that the *Os Tincæ* and *Collum minus* were fill'd with a gritty Substance, hard as Stone, which I take to be the Humour  
sepa-

ſeparated there, and coagulated by Time. Mr. Cooper *Tab. 15. Fig. 4.* ſays he found the ſame Parts fill'd with a glutinous Matter, which he thinks is uſeful to prevent Abortion; which if vitiated, Impregnation is hinder'd.

The Liver and other parts contain'd in the *Abdomen*, were forc'd into an incredible ſmall Compaſs (and by that Preſſure a little chang'd in Shape) to perform their Office ſo long; to which the Muſcles of the *Abdomen*, diſtended ſo as to be ſcarce diſcernible, could give but little, if any, Aſſiſtance.

The Awe that People have here for dead Bodies, tho' never ſo prejudicial to the Living, would not ſuffer her Friends to let me make any farther Enquiry; ſo that I can ſend no Account of any other Part. The ſame Error hindered me examining another Woman, who died here about a Week after, of an *Aſcites* which ſhe had had Forty Years, any farther than to be ſatiſfied ſhe had Seven Gallons of Water contain'd between the Duplicatures of the *Peritoneum*, and none in the Cavity of the *Abdomen*.

---

IV. *Methodus ſingularis quâ Solis Parallaxis ſive diſtantia à Terra, ope Veneris intra Solem conſpiciendæ, tuto determinari poterit: propoſita coram Regia Societate ab Edm. Halleio J. U. D. ejusdem Societatis Secretario.*

**P**Lurima ſunt maxime quidem paradoxa, omnemque fidem apud vulgus ſuperantia, quæ tamen adhibitis Mathematicarum Scientiarum principiis levi negotio enodantur. Ac ſane nullum problema magis arduum ac difficile videbitur, quam eſt *Solis à Terra diſtantiæ* vero proximam determinare; quod tamen obtentis accuratis  
qui.

quibusdam observationibus, ad electa & prævisa tempora peractis, non multo opere efficietur. Id quod inclytæ huic Societati, quam immortalem fore auguror, in hac differtatione ob oculos ponere libet, ut junioribus nostris Astronomis, quibus forsân hæc observare ob minorem ætatem obtingere potest, viam præmonstrem, quâ immensam Solis distantiam intra quingentesimam sui partem rite dimeriri poterint.

Notum autem vobis est hanc distantiam à diversis Astronomiæ authoribus diversam fingi, prout cuique ex conjecturâ probabile visum est; à *Ptoleæo* quidem ejusque affectis, uti & *Copernico* & *Tychoni Braheo*, *Terræ* semidiametris mille & ducentis, *Keplero* ter mille quingentis fere. *Ricciolus* distantiam *Keplerianam* duplicat, quæ *Hevelius* dimidio tantum auget. At vero visis in *Solis* disco ope Telescopii Planetis *Veneri* & *Mercurio* mutato fulgore nudatis, tandem compertum est Planetarum diametros visibiles multo minores esse quam eatenus haberentur; *Venerisque* Semidiametrum è *Sole* visam non nisi quartam minuti primi partem vel quindecim secunda subtendere; *Mercurique* semidiametrum, ad mediam ipsius à *Sole* distantiam, sub angulo decem tantum secundorum conspici; atque sub eodem etiam *Saturni* semidiametrum è *Sole* videri. *Jovis* autem Planetarum maximi semidiametrum non nisi tertiam minuti primi partem apud *Solem* subtendere. Unde, servatâ analogiâ, nonnullis è modernis Astronomis visum est, *Terræ* quoque semidiametrum è *Sole* conspectam, medio loco inter *Jovis* majorem & *Saturni* & *Mercurii* minorem angulum subtendere, *Venerisque* æqualem, nempe quindecim secundorum: adeoque *Solem* à *Terrâ* quatuordecim fere millibus semidiametrorum *Terræ* distare. Iisdem autem Authoribus, aliud argumentum paulo ampliavit hanc distantiam: quoniam enim *Luna* diameter paulo major est quartâ parte diametri *Terræ*, si Parallaxis *Solis* ponatur quindecim minutorum secundorum, fieret

*Luna*

*Luna* corpus corpore *Mercurii* majus, Planeta scil. secundarius primario major ; quod concinnitati Systematis mundani contrariari videretur. E contra vero *Venerem* inferiorem & Satellitio destitutam, majorem esse *Terrâ* nostrâ superiori & tam insignem comitem nascâ, vix concedere videtur eadem concinnitas. Ut itaque medio loco incedamus, ponatur *Terræ* semidiameter è *Sole* visa, seu quod idem est, *Solis* Parallaxis horizontalis, duodecim secundorum cum semisse: unde *Luna* minor erit *Mercurio* & *Terra Venere* major ; ac proveniet *Solis* a *Terra* distantia sedecies mille cum quingentis *Terræ* semidiametris proxime. Huic autem distantie in præsentiatum assensum præbeo, usq; dum Experimento quod proponimus quanta sit certius constet. Nec moror auctoritatem quantumvis gravem eorum qui *Solem* ultra hos terminos in immensum evehunt, freti observationibus vibrantis Penduli, determinandis his angulorum minutiis, uti videtur, haud satis fidis: saltem hâc methodo tentanti Parallaxis aliquando nulla, aliquando etiam negativa occurrit; hoc est distantia vel infinita fiet, vel infinito major: quod absurdum. Er, ut verum fatear, minuta secunda vel etiam dena secunda instrumentis quantumvis assidue factis certo distinguere vix homini datum est; atque adco minime mirandum, si tantorum Artificum multos & ingeniosos conatus hæcenus eluserit rei ipsius maxima subtilitas.

Dum autem ante 40 fere annos, in Insula *Sancta Helena*, syderum polum Australem ambientium observationibus operam darem; contigit mihi *Mercurium* sub *Solis* disco transeuntem omni adhibitâ diligentia observare: quodque mihi præter spem feliciter successit, momentum quo *Mercurius* ingrediens *Solis* limbum interius contingere visus est, pariterque momentum quo egrediens limbum *Solis* strinxit, facto angulo contactû interioris, Tubo oprimo viginti quatuor pedum accuratissime obtinui. Unde pro composito habui intervallum quo *Mercurius* totus intra *Solis* discum

discum tum temporis apparuit, etiam absque errore unus minuti secundi temporis: Nam filum luminis Solaris, inter limbum planetæ obscurum & *Solis* lucidum interceptum, quantumvis tenue in oculos incurrere visum est; & in ictu oculi, denticulus in limbo *Solis* a *Mercurio* ingrediente factus evanescere, uti ab egrediente factus quasi momento incipere. Hoc autem perspecto statim intellexi *Solis* Parallaxin ex hujusmodi observationibus rite concludi posse, si modo *Mercurius Terris* vicinior majorem haberet parallaxin à *Sole*; etenim hæc parallaxium differentia tantilla est, ut semper minor sit ipsa Solari quam quærimus; proinde *Mercurius*, licet frequenter intra *Solem* videndus, huic nostro negotio vix satis aptus habebitur.

Restat itaque *Veneris* transitus per *Solis* discum, cujus parallaxis quadruplo fere major Solari, maxime sensibiles efficiet differentias, inter spatia temporis quibus *Venus Solem* perambulare videbitur, in diversis *Terra* nostræ regionibus. Ex his autem differentiis debito modo observatis, dico determinari posse *Solis* parallaxin etiam intra scrupuli secundi exiguum partem. Neque alia instrumenta postulamus præter *Telescopia* & *Horologia* vulgaria sed bona: & in Observatoribus non nisi fides & diligentia, cum modica rerum Astronomicarum peritia desiderantur. Non enim opus est ut Latitudo Loci scrupulosè inquiretur, nec ut Horæ ipsæ respectu meridiani accurate determinantur: sufficit, Horologiis ad Cæli revolutiones probe correctis, si numerentur tempora à totali Ingressu *Veneris* infra discum *Solis*, ad principium Egressus ex eodem; cum scilicet primum incipiat Globus *Veneris* opacus limbum *Solis* lucidum attingere; quæ quidem momenta, propria experientia novi, ad ipsum secundum temporis minutum observari posse.

Ob leges autem motuum admodum arctas, rarissime intra *Solis* orbem conspicitur *Venus*, ac per plus quam centum & viginti annorum decursum, ne semel

quidem ibidem videbitur ; nempe ab anno 1639. (cum præclaro Juveni *Horroxio* nostro, eique primo & soli à rerum conditu, jucundissimum hoc spectaculum obtrigit,) usque in annum 1761, quo juxta Theorias quas hæcenus cælo conformes experimur, Srella *Veneris* iterum subtercurret *Solem*, *Maii* 26. mane ; \* ita ut *Londini*, horâ fere sextâ matutinâ in medio disci Solaris expectanda sit, nec nisi quatuor minutis centro *Solis* Australior. Duratio autem hujus transitus erit octo fere Horarum, nempe à secunda usque in decimam fere matutinam. Atque adeo ingressus minime *Anglis* conspicuus erit : cum autem *Sol* tum temporis occupaturus sit 16. *Geminorum* gradum, viginti tres ferme gradus in Boream declinans ; per totam quasi Zonam frigidam Septentrionalem inocciduis conspicietur : ac proinde qui littus *Norwegiæ* incolunt ultra Urbem *Nidrosiam*, quam *Drontem* vocant, usque ad Promontorium ejus *Boreale*, *Venerem Solis* discum subingredientem observare poterunt ; ac fortasse *Scotis* Borealioribus & Insulæ *Hetlandia*, olim *Thylen* dictæ, incolis, in oriente *Sole* ingressus ille conspici poterit. Quo tempore vero *Venus Solis* centro proxima erit, *Sol* verticalis erit supra littora Borealia sinus *Gangetici*, vel potius regni *Peguani* ; ac proinde in Regionibus circumvicinis, cum *Sol* in ingressu *Veneris* quatuor fere horis distabit ad ortum, & in egressu totidem fere ad occasum, accelerabitur motus apparens *Veneris* intra *Solem* duplo fere parallaxeos horizontalis *Veneris* à *Sole* ; quia *Venus* tunc ab ortu in occasum fertur retrogradè, interea dum oculus ad *Terræ* superficiem positus in contrarias partes ab occasu in ortum gyrat.

Positâ autem parallaxi *Solis*, uti diximus, duodecim secundorum cum semisse, erit parallaxis *Veneris* 43<sup>um</sup> secundorum ; & sublatâ parallaxi *Solis*, restabit saltem semimutuum pro parallaxi Horizontali *Veneris* à *Sole*, ac proinde dodrante, saltem minuti promovebitur *Veneris* motus à parallaxi illa, interea dum *Solis* discum percurrit, in his scili-



scilicet Poli altitudinibus quæ Tropico vicinæ sunt ; atque adhuc amplius in vicinia *Æquatoris*. *Venus* autem tum temporis satis accurate quatuor minuta prima singulis horis intra *Solem* conficiet ; ac propterea dodranti minuti un decim saltem temporis minuta prima competunt, quibus duratio *Eclipseos* hujus *Veneræ* ob parallaxin contrahetur. Atque ex hac contractione solâ liceret de parallaxi quam quærimus tutò pronunciare, si modo darentur *Solis* diameter *Veneris*que Latitudo in minimis accuratæ ; quas tamen ad computum postulare, in re tam subtili, haud integrum est.

Procuranda est igitur alia observatio, si fieri possit, in locis illis ubi medium *Solis* occupat *Venus* in ipso Medianoctio ; nempe sub Meridiano priori opposito, *i. e.* sex quasi horis vel 90 gradibus *Londino* occidentaliore, & ubi *Venus* paulo ante occasum *Solem* subintrat, paulo post ortum, exit ; id quod fiet in dicto Meridiano, sub altitudine Poli Borei quinquaginta sex circiter graduum : hoc est, in eo Sinu qui *Hudsoni* dicitur, ad Portum ejus cui nomen *Nelsoni* inditum. In locis enim huic circumvicinis parallaxis *Veneris* durationem transitus protrahet, & sex saltem temporis minutis longiorem efficiet ; quia dum *Sol* ab occasu in ortum sub Polo tendere videtur, ea loca in disco *Terræ*, motu contrario in occasum ferri videbuntur, hoc est motu cum motu proprio *Veneris* conspirante ; proinde tardius moveri videbitur *Venus* intra *Solem*, ac cum diuturniore mora discum ejus pertransire.

Si itaque in utroque loco hic transitus ab Artificibus idoneis contigerit debite observari, manifestum est totis septendecim minutis longiorem futuram esse moram in portu *Nelsoni* observabilem, quam quæ apud *Indos* orientales expectanda est : nec multum refert an ad Fortalitium *Sancti Georgii* vulgo *Maderás* dictum, vel ad *Bencoulam* in litore occiduo Insulæ *Sumatræ* prope æquatorem capia-tur observatio, si *Anglis* tum temporis hæc studia curæ fu-

erint. Si vero *Gallis* his rebus invigilare placuerit, non incommode apud *Pondechery* se sistet Observator in litore *Sinus Gangetici* occidentali, sub altitudine Poli duodecim fere graduum. *Batavis* autem celeberrimum *Batavia* suæ Emporium Observatorium huic negotio satis aptum ministrat, si modo illis etiam animus fuerit hac in parte cœlorum scientiam promovere. Ac sane vellem diversis in locis ejusdem Phænomeni observationes à pluribus institui, tum ad majorem adstruendam ex consensu fidem, tum ne Nubium interventu frustraretur singularis Spectator, eo spectaculo quod nescio an denuo visuri sunt hujus & subsequents seculi Mortales ; & à quo pendet Problematis nobilissimi & aliunde inaccessi solutio certa & adæquata. Curiosis igitur syderum scrutatoribus, quibus, nobis vita functis, hæc observanda reservantur, iterum iterumque commendamus ut, moniti hujus nostri memores, observationi peragendæ strenue totisque viribus incumbant ; iisque fausta omnia exoptamus & vovemus, præprimis ne nubili cœli importuna obscuritate exoptatissimo spectaculo priventur ; utque tandem Orbium cœlestium magnitudines intra arctiores limites coercitæ in eorum gloriam famamque sempiternam cedant.

Diximus autem hac ratione Solis Parallaxin intra quingentesimam sui partem investigari posse, id quod nonnullis mirum sine dubio videbitur. Veruntamen si in utroque è locis nuper designatis accurata habeatur observatio ; jam monstravimus, totis septendecim minutis differre inter se durationes *Eclipseon* harum *Venerearum*, ex Hypothesi scilicet quod Solis parallaxis fuerit duodecim cum dimidio minutorum secundorum. Quod si major vel minor reperiat ex observatione hæc differentia, in eadem fere ratione major vel minor erit Solis parallaxis. Cumque 17 minuta prima temporis competant duodecim secundis cum dimidio parallaxeos Solaris ; pro unoquoque parallaxeos minuto secundo, orietur differentia plusquam 80 secundorum

dorum minutorum temporis ; adeoque si habeatur differentia hæc intra bina secunda vera & comprobata, intra quadragesimam partem unius secundi minuti constabit quanta sit Solis Parallaxis ; ac proinde distantia ejus determinabitur intra quingentesimam sui partem, saltem si parallaxis non minor reperiatur eâ quam supposuimus : quadragies enim duodecim cum dimidio fiunt quingenti.

Hactenus Astronomice doctis satis superque rem indicasse mihi videor, quos etiam monitos velim, me in hoc argumento, Latitudinis Planetæ rationem non habuisse, tum ad vitandas calculi intricatioris molestias, conclusionem etiam minus evidentem reddituras ; tum ob motum Nodorum *Veneris* nondum compertum, nec nisi ex hujusmodi corporalibus Planetæ cum *Sole* Conjunctionibus rite determinandum. Non enim conclusum est *Venerem* quatuor minuta infra *Solis* centrum transituram, nisi ex Hypothesi quod Planum Orbitæ *Veneris*, in Sphæra stellarum fixarum immobile, Nodos suos iisdem in locis habiturum sit, ubi anno 1639 inventi sunt. Quod si tramite Australiori transeat anno 1761, liquido patebit Nodos regredi ; si vero Borealiori, progredi inter Fixas ; idque in ratione  $5\frac{1}{2}$  min. in centum annis *Julianis*, pro unoquoque minuto, quo via *Veneris* tum temporis plus vel minus distabit à *Solis* centro quam dictis quatuor minutis. Differentia autem inter durationes harum Eclipsium paulò minor fiet septendecim minutis, ob Latitudinem *Veneris* Australem ; major vero futura, si, procedentibus Nodis, ad Boream centri *Solem* transferit.

In eorum autem gratiam, qui cum observandis syderibus oblectentur, nondum tamen integram Parallaxium doctrinam hauserint, libet Schemate simulque Calculo paulo accuratiore, rem plenius exponere.

Ponamus igitur, anno 1761, *Maii* 25°. 17<sup>h</sup>. 55'. *Londoni*, *Solem* occupaturum  $\pi$  15°. 37'. ac proinde ad centrum ejus *Eclipticam* tendere in Boream angulo 6°. 10'.

*Veneris*.

*Veneris* autem visibilem intra *Solis* discum Viam tum temporis descendere in Austrum, facto angulo cum Ecliptica  $8^{\circ}.28'$ : proinde via *Veneris* tendet parum in Austrum respectu æquatoris, intersecans declinationis parallelos angulo  $2^{\circ}.18'$ . Ponamus etiam *Venerem* ad dictum tempus *Solis* centro proximam fore, ac ab eodem quatuor minutis distare ad Austrum; singulisque horis etiam quatuor minuta prima intra *Solem* motu retrogrado describere. Erit autem *Solis* Semidiameter  $15'.51''$ . proxime, *Veneris* vero  $0'.37''\frac{1}{2}$ . Ac supponamus, experimenti gratia, differentiam parallaxium Horizontalium *Veneris* & *Solis*, quam quærimus,  $0'.31''$  esse, qualis ex supposita *Solis* Parallaxi  $0'.12''\frac{1}{2}$  elicitur. Describatur itaque (Fig. II.) centro *C* circellus *AEBD*, cujus semidiameter sit  $0'.31''$ . discum Terræ repræsentans, & in eo Ellipses parallelorum  $22$  &  $56$  grad. Latitudinis Borealis, modo jam ad construendas Eclipses Solares ab Astronomis usitato, ut *DabE*, *cde*: sit autem *BCA* Meridianus in quo *Sol*; ad quem inclinetur recta *FHG* Viam *Veneris* designans angulo  $2^{\circ}.18'$ , quæque distet à centro *C* 240 partibus qualium *BC* est 31; & de *C* cadat recta *CH* ipsi *FG* perpendicularis. Ac posito planeta in *H* ad  $17^h.55'$ , vel  $5^h.55'$  mane, dividatur recta *FHG* in spatia Horaria III. IV, IV. V, V. VI, &c. ipsi *CH*, hoc est quatuor minutis æqualia. Fiat etiam recta *KL*, æqualis differentię apparentium Semidiametrorum *Solis* & *Veneris* sive  $15'.13''\frac{1}{2}$ . Et Circulus radio *KL*, centro vero quolibet puncto intra circellum Disci *Terræ* descriptus, occurreret rectæ *FG* in puncto denotante quota hora *Londini* numerabitur, cum in eo *Terræ* superficiici loco, qui sumpto in disco puncto subjacet, *Venus* angulo contactus interioris *Solis* limbum continget. Ac si centro *C* radio *KL* descriptus circulus occurrat ipsi *FG* in punctis *F* & *G* erunt rectæ *FH*, *HG* =  $14'.41''$ , id quod percurrere videbitur *Venus* tribus horis cum 40 min. Cadet igitur  
*F* in

*F* in  $11^h. 15'$ , *Londini*; *G* vero in  $IX^h. 35'$  mane. Unde manifestum est quod, si Terræ magnitudo, ob immensam distantiam, quasi in punctum evanesceret; vel si motu diurno destituta *Solem* haberet eidem puncto *C* semper verticalem, Eclipsæos hujus Mora integra per septem horas cum triente duraret. Verum Terrâ interea motu motui *Veneris* contrario gyratâ per  $110$  grad. Longitudinis suæ, ac proinde contractâ dictæ moræ duratione, puta  $12$  min. proveniet ea  $7^h. 8'$ . proximè, sive  $107$  grad.

Jam in ipso Meridiano *Venus Solis* centro proxima erit ad Ostium orientale fluminis *Gangis*, ubi poli altitudo est  $22$  grad. circiter. Locus igitur ille utrinque æqualiter distabit à Sole, in momentis introitus & exitus planetæ, nempe  $53^{\circ}\frac{1}{2}$  grad. ut sunt puncta *a*, *b*, in parallelo majore *D a b E*. Erit autem Diameter *AB* ad distantiam *a b* ut quadratum Radii ad contentum sub Sinubus  $53^{\circ}\frac{1}{2}$  &  $68^{\circ}$  grad. hoc est, ut  $1'. 02''$  ad  $0'. 46''. 13'''$ ; ac calculo rite instituto (quem ne Lectori tædio sit, omittere præstat) invenio quod circulus centro *a* & radio *K L* descriptus occurreret rectæ *F H*, in puncto *M*, ad  $11^h. 20'. 40''$ ; centro vero *b* descriptus occurreret ipsi *H G* in *N*, ad  $IX^h. 29' 22''$ ; horis sci icet *Londini* numeratis; proinde tota *Venus* intra *Solem* conspicietur ad *Gangis* ripas, per  $7^h. 8'. 42''$ . Rectè igitur posuimus durationem fore  $7^h. 8'$ ; cum pars minuti hic nullius sit momenti.

Aprato autem calculo ad *Portum Nelsoni*, invenio, quod Sole jamjam occasuro, discum ejus subitura sit *Venus*; statim vero ab ortu ejus exitura ab eodem; Loco illo interea per Hemisphærium à Sole aversum de *c* ad *d* translato, motu motui *Veneris* conspirante. Mora igitur *Veneris* intra *Solem* diuturnior fiet ob Parallaxin, puta quatuor minutis; ut sit omnino  $7^h. 24'$ . sive  $111$  grad. æquatoris. Cumque Latitudo Loci sit  $56$  gr, erit ut Quadratum Radii ad contentum sub Sinubus  $55^{\circ}\frac{1}{2}$  &  $34$  grad ita  $AB = 1'. 02''$  ad  $cd = 28''. 33$ . Ac calculo rite pe-

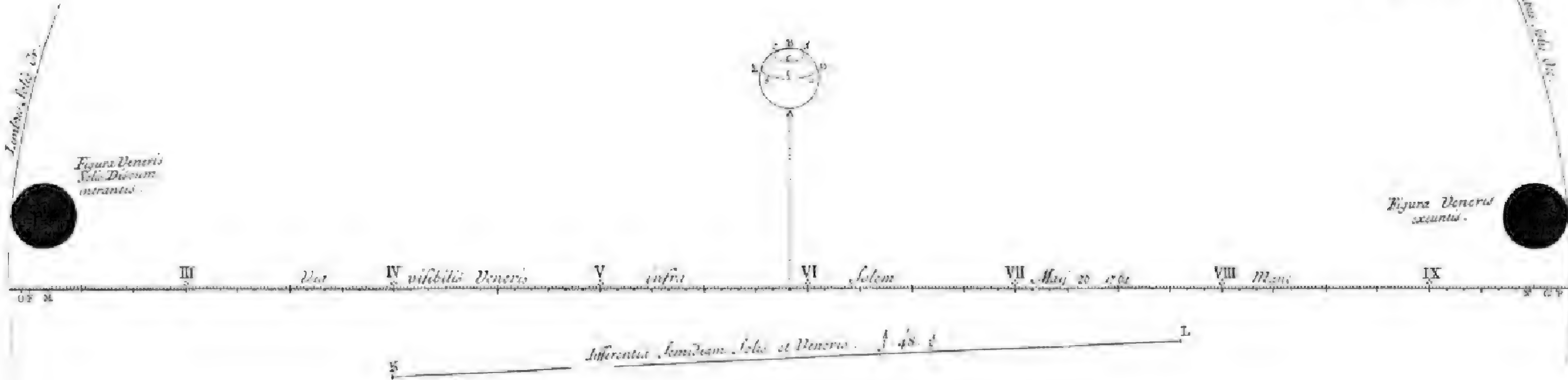
racto

recto constabit, circulum centro  $c$  radio  $KL$  descriptum rectæ  $FH$  occursurum in  $O$ , ad  $11^h. 12'. 45''$ , centro vero  $d$  descriptum ipsi  $HG$  in  $P$ , ad  $IX^h. 36''. 37''$ . Quocirca duratio Moræ ad *Nelsoni* portum erit  $7^h. 23'. 52''$ ; major scilicet quam ad ostia *Gangis* totis  $15'. 10''$  temporis. Quod si *Venus* absque Latitudine transierit, fiet dicta differentia  $18'. 40''$ ; Si vero quatuor minutis *Solis* centro fuerit Borealis, ad  $21'. 40''$  augebitur eadem differentia, multo major futura auctâ Planetæ Latitudine Borea.

*Londini* autem, ex prædictis Hypothesibus, consequitur *Venerem* jam tum infra *Solem* ingressam orituram; & ad  $9^h. 37'$  mane, in Egressu *Solis* limbum interius contacturam; ac denique non nisi horâ  $9^h. 56'$ , orbem ejus integrum relicturam esse.

Isdem etiam Hypothesibus constat *Venerem* extremum *Solis* limbum Boreum quasi centro suo stringere debere, Anno 1769, *Maii*,  $23^o. 11^h. 00'$ , ita ut, ob Parallaxin, in Borealibus *Norwegiæ* partibus, tota intra *Solem* inocciduum apparere poterit: dum in litoribus *Peruvia* & *Chili*, vix exiguo sui segmento cadentis *Solis* disco quasi inequitare videbitur; uti in Insulis *Moluccis* earumque vicinâ, oriente *Sole*. Quod si Nodi *Veneris* retrocedere reperiantur (ut ob nuperas quasdam observationes suspicio est) tum toto corpore intra orbem *Solis* ubique conspicua, maximâ harum Eclipsæon differentiâ argumentum Parallaxeos *Solaris* præbebit adhuc multo luculentius.

Quomodo autem ex observatis alicubi apud *Indos* Orientales, anno 1761, Ingressu & Egressu *Veneris*, & cum Exitu ejus apud Nos observabili collatis, eadem Parallaxis derivari poterit; aptando scilicet angulos Trianguli specie dati in trium Circulorum æqualium circumferentias, alia occasione docebitur.



# PHILOSOPHICAL TRANSACTIONS.

For the Months of July, August and September, 1716.

## The C O N T E N T S.

- I. *An Account of the Cause of the late remarkable Appearance of the Planet Venus, seen this Summer, for many Days together, in the Day time.* By Edm. Halley, R. S. Secr.
- II. *A Letter of the Reverend Mr. John Sackett, A. M. to Dr. Brook Taylor, Reg. Soc. Secr. Giving an Account of a very uncommon sinking of the Earth, near Folkestone in Kent.*
- III. *Miscellaneous Observations made about Rome, Naples and some other Countries, in the Year 1683 and 1684; and communicated to the Publisher by Tancred Robinson. M. D. R. S. S.*
- IV. *An Account of the Mischiefs ensuing the swallowing of the Stones of Bullace and Sloes.* By the Reverend William Derham, Prebendary of Windsor, and F. R. S.
- V. *Observations and Experiments relating to the Motion of the Sap in Vegetables.* By Mr. Richard Bradley, R. S. S.
- VI. *Some Microscopical Observations, and Curious Remarks on the Vegetation and exceeding quick Propagation of Moldiness, on the Substance of a Melon.* Communicated by the same.
- VII. *The Art of Living under Water: Or, a Discourse concerning the Means of furnishing Air at the Bottom of the Sea, in any ordinary Depths.* By Edm. Halley, LL. D. Secretary to the Royal Society.
- VIII. *Observations on the Glands in the Human Spleen; and on a Fracture in the upper part of the Thigh-bone.* By J. Douglass, M. D. and R. S. S.
- IX. *An Account of a Book. DISSERTATIO de DEASALUTE, In qua illius Symbola. Tempia, Statuæ, Nummi, Inscriptiones exhibentur, illustantur. Auctore Guilhelmo Musgrave G. F. è Coll. Exon Oxonii: Typis L. Lichfeld: Impensis Phil. Teo, Bibliopolæ Exon. Anno MDCCXVI.*



I. *An Account of the Cause of the late remarkable Appearance of the Planet Venus, seen this Summer, for many Days together, in the Day time.* By Edm. Halley, R. S. Secr.

**I**T may justly be reckoned one of the principal Uses of the Mathematical Sciences, that they are in many Cases able to prevent the Superstition of the unskilful Vulgar; and by shewing the genuine Causes of rare Appearances, to deliver them from the vain apprehensions they are apt to entertain of what they call *Prodigies*; which sometimes, by the Artifices of designing Men, have been made use of to very evil purposes.

Of this kind was the late Appearance of *Venus* in the Day time, generally taken notice of about *London* and elsewhere; and by some reckoned to be *Prodigious*. This put me upon the enquiry, how it came to pass that at that time the *Planet* should be so plainly seen by Day, whereas she rarely shews her self so, unless to those who know exactly where to look for her. To resolve this, the following Problem arose, *viz.* To find the Situation of the *Planet* in respect of the *Earth*, when the *Area* of the illuminated part of her Disk is a *Maximum*.

To investigate this *Maximum*, I found it requisite to assume the following *Lemmata*. I. That the visible *Areas* of the Disk of the same *Planet*, at differing Distances, are always reciprocally as the Squares of those Distances; which is evident from the first Principles of *Opticks*. II. That the *Area* of the whole Disk of the *Planet* is to the *Area* of the illuminated Part thereof, as the Diameter of a Circle to the Versed-Sine of the exterior Angle at the *Planet*, in the Triangle at whose Angles are the *Sun*, *Earth*, and *Planet*. III. That in all plain Triangles, four times the Rectangle of the Sides containing any Angle, is to the excess of the Square of the Sum of the Sides above the Square of the Base, as the Diameter is to the Versed-Sine of the

the

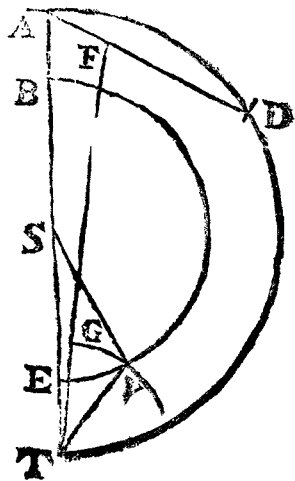
the Complement of the contained Angle to a Semicircle, which I call the exterior Angle: This is a new *Theorem* of good use in *Trigonometry*, and easily proved from the 12th and 13th of the II. *Elem. Euclid*.

This premised, putting  $m$  for the Distance of the *Sun* and *Earth*, and  $n$  for that of the *Sun* and *Venus*, and  $x$  for the Distance of the *Earth* and *Venus*, or the third Side of the Triangle which we seek; by the third *Lemma*,  $4nx$ , will be to the excess of the Square of  $n+x$  above the Square of  $m$ , as the *Area* of the whole Disk of *Venus* to the *Area* of the part illuminated; and by the first *Lemma*, the *Area's* of her whole Disk are at all times as the Squares of  $x$  reciprocally; whence the Quantity  $\frac{nn + 2nx + xx - mm}{4nx^3}$  will in all Cases be

proportional to the *Area* of the illuminated part.

Now that this should be a *Maximum*, it is required that the Fluxion thereof be equal to 0, or that the Negative parts thereof be equal to the Affirmative; that is, that  $2nx + 2xx \times 4nx^3 = 12nx^2x \times nn + 2nx + xx - mm$ ; and dividing all by  $4nx^2x$ , the Equation becomes  $2nx + 2xx = 3nn + 6nx + 3xx - 3mm$ . Consequently  $3nn + 4nx + xx = 3mm$ , and therefore  $x = \sqrt{3mm + nn} - 2n$ .

From hence a ready and not inelegant Geometrical Construction (if I may be allowed to say so) becomes obvious; for with the Center  $S$  and Radius  $ST = m$ , describe the Semicircle  $TD A$ ; and with the same Center and Radius  $SE = n$ , the Semicircle  $EV B$ ; which two Semicircles shall represent the Orbs of the *Earth* and *Venus*. Make the chord  $AD$  equal to the Radius  $ST$ , and from  $D$  towards  $A$ , lay off  $DF = SE$ ; draw  $TF$ , and thereon place  $FG = BE = 2n$ , and with the Center  $T$  and Radius



*TG* describe the arch *GV*, cutting the Semicircle *BVE* in *V*; and draw the lines *SV*, *TV*: I say the Triangle *STV* is Similar to that at whose Angles are the *Sun*, *Earth* and *Venus*, at the time when the *Area* of the enlightened part of that Planet's Disk, as seen from the *Earth*, is greatest. How this Geometrical Effect follows from the Equation is too evident to need repetition.

In consequence of this Solution, I find this *Maximum* always to happen, when the Planet is about forty Degrees distant from the *Sun*; and the times thereof, about the middle between her greatest Elongations on both sides from him, and her retrograde Conjunctions with him; when little more than a quarter of her visible Disk is luminous, and resembling the Moon of about five Days old; and notwithstanding that her Diameter is at that time but 50 Seconds, yet she shines with so strong a Beam, as to surpass the united light of all the fixt Stars that appear with her, and casts a very strong Shade on the Horizontal plain whereon they all shine: an irrefragable Argument to prove that the Disks of the fixt Stars are unconceivably small, and next to nothing; since shining with a native Light, so many of them do not equal the reflex Light of one quarter of a Disk of less than a Minute Diameter.

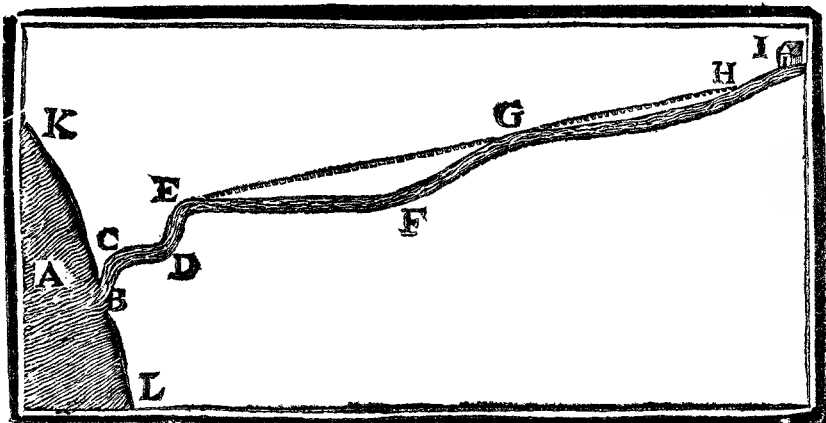
In this situation *Venus* was found in *July* last, on the tenth Day, about which time, when the *Sun* grew low, she was very plainly seen in the Day time, for many Days together; as she might have been in the Mornings, about the latter end of *September*. But this, arising from the Causes we have now shewn, is nothing uncommon; for every eighth Year it returns again, so that the Planet may be seen on the same Day of the Month and Hour, very nearly in the same place; as all acquainted with the Heavenly Motions must know.

Lastly, it may not be amiss to note that the Equation  $x = \sqrt{3mm + nn} - 2n$  has a Limit; for if  $n$  be equal to  $\frac{1}{4}m$ , the point *V* will fall on *B*; and the whole Disk of a Planet at that distance from the Sun would be the *Maximum*, viz. when in its superior Conjunction with the *Sun*. And the like if  $n$  were less than  $\frac{1}{4}m$ ; the Arch *GV* in such Case not intersecting the Semicircle *BE*.

II. *A Letter of the Reverend Mr. John Sackett,*  
*A. M. to Dr. Brook Taylor, Reg. Soc. Secr.*  
*Giving an Account of a very uncommon sinking of*  
*the Earth, near Folkestone in Kent.*

SIR,

I Am about to give you the best Account I can of what is remarkable, and known almost to all hereabouts, concerning the pressing forward of the Cliffs, and sinking of the Hills in the Neighbourhood of our Town of *Folkestone*. I begin with giving you a Sketch of the Situation of the Country. This I shall do by describing a strait Road from what we call the *Mooring-Rock*, to *Tarlingham-House*; the manner of the Country, as to the Rising and Falling, being much the same, for about a Mile on either Hand of the Road described.



.A. The *Mooring-Rock*, about half-way between high and low Water-Mark.

D d d d

B

*B.* The Foot of the Cliff 50 Yards from the Rock.

*C.* The Top of the Cliff, about 6 Yards high.

*C D.* A Plain of 50 Yards.

*D E.* A cragged Cliff, of 60 Yards high.

*E F.* A Plain above a Mile long.

*F G.* An Hill of steep Ascent, near half a Mile.

*G H.* The Land from the Top of the Hill to the House, near a Mile.

*I.* *Tarlingham House*, lying near 2 Miles and a half N. N. W. from the Rock.

*E G H.* A Line of Sight.

*K B L.* The Shore at High Water Mark.

I hope Sir you will understand the Situation of the Place pretty well, tho' I have not observed exact Proportion in the Sketch; which the Paper would not allow after I had taken the Rise of the Cliffs so high, which I thought proper for the more particular Describing of them.

The *Mooring-Rock* (tho' it lies surrounded with great numbers of other Rocks) is it self a most noted one, known by this Name, time out of mind. At this Vessels use to be moored, while they are loading other Rocks; which they take from hence, not only for our own *Pier Heads*, but for those of *Dover Pier*; and a very great Quantity of them were Shipt, in the time of *Oliver's* Usurpation, and carried to *Dunkirk*, for the Service of that Harbour.

This Rock has remain'd fixt thus, for the memory of Man; and old Men have observed, that, for forty Years and upwards, the distance between it and the Foot of the lesser Cliff *A B.* has been much the same; neither can they be much out in their Guess, the Distance being so small. Tho' there seems nothing extraordinary in this, yet its what they take special Notice of, to their great surprize: for they say, and prove by good Marks and Tokens,

kens, that the lesser Cliff *BC* has been constantly falling in, insomuch, that from time to time, in their Memory, near 10 Rods forward to the Land has been carried away by the Sea. From whence, as it appears that the Plain between the Top of the lesser Cliff and the Foot of the higher *CD* has been formerly double the Breadth that it is at present, so the distance been the Rock and the Foot of the lesser or lower Cliff *AB*. should have increased in Proportion, and would have been double at present, to what it has been formerly: But this Distance remaining the same (as is above noted) or rather less (in the Opinion of many) is what is greatly wonder'd at: nor can it be accounted for otherwise, than by supposing that the Land pressing forward into the Sea is washed away by the high Tides; and, as often as this happens, presses forward again. This pressing forward of the Land into the Sea, would be incredible, were it not shewn to be matter of Fact; and that not only at this one Place of Observation, but by like Observations all along this Coast, as far as the Situation continues the same.

Now, Sir, let us climb both these cragged Cliffs, and place our selves at the Top of the higher One, at the Point *E*. And here we are to observe, that (as old Men inform us) upward of forty Years ago, not so much as the Top of *Tarlingham-House* could be discern'd, neither from hence, nor yet a good Distance off at Sea; but it discover'd it self by degrees, till at this Day, not only the whole House, but a great Tract of Land below it, is plainly to be seen, as in the Line of Sight *EGH*. The Tract of Land is more in Proportion than describ'd in the Sketch, between the Point at *H* and the House. In this there can be no Fallacy; and we can ascribe it to nothing less than the sinking of the Hills (for their Tops could never wear  
D d d d 2 away

away considerably, being always cover'd with Grass, and never broken up by the Plough or otherwise). These Hills are all of Chalk, and have probably very large Caverns within, Springs of Water always flowing plentifully from the foot of them; and I have had it observ'd to me, that upon their Tops frequent Cracks have been taken notice of. Whatever be the Cause of it, 'tis not to be doubted but that these Hills are greatly sunk. And this sinking of the Hills, the People at this Place believe, forces the Cliffs and all the Land forward into the Sea. The Cliffs consist of great ragged Sand-Stones till we come to near a Yard (at some places more) of the Bottom; then we meet with what they call a Slipe, *i. e.* a slippery sort of Clay always wet. Upon this Slipe at the bottom, they presume that the hard Stony Land above slides forwards toward the Sea, as a Ship is launch'd upon tallow'd Planks. I thought it proper to give you this account of the Nature of the Earth; and withal to mingle with it the Opinion of the People, that you might perceive they are so far from doubting of the Truth of what is abovewritten, that they endeavour to find some Solution of it, as being a thing not more strange than true. If I should take all the Hands that can be got to testify the Truth of this, it would make too large a Roll, so I shall chuse only a few of the most antient and of best Credit.

I assure my self that I have Credit enough with you to be believed upon my own single Subscription, that I am,

*S I R, Yours,*

*Folkestone in Kent,  
February 24, 1715-16,*

John Sackette.

We

We whose Names are underwritten do hereby testify the Truth of the Matters of Fact in the within written Letter related,

*Benjamin Master*, a Jurat of the Town, aged 74.

*Robert Hammond*, Senior, a Jurat of the Town, aged 77.

*William Godden*, a Fisherman, aged 74.

*Thomas Marsh*, a Fisherman, aged 72.

*William Hall*, a Fisherman, aged 73.

*James Godden*, a Fisherman, upward of 60.

III. *Miscellaneous Observations made about Rome, Naples and some other Countries, in the Year 1683 and 1684; and communicated to the Publisher by Tancred Robinson M. D. R. S. S.*

SIR,

YOU having been pleas'd to think some of my Observations might be agreeable to the Publick, I shall here freely give you them (such as they are) omitting those that were formerly extracted out of the MSS. Diaries of my Travels, some of which are Printed in several *Philosophical Transactions*, and others in some of Mr. Ray's English Tracts.

In my Journey from *Rome* to *Naples* I observ'd on the Rubbish of the *Tre Taberne* an unusual Vegetable for that place, remote from Town or House, which was the *Ficus Indica Spinosa* commonly call'd the *Opuntia* or *Tuna*, and by our Writers of *America* the *Prickly-Pear*, whose Juice gives the Urine a red Colour; when I came to *Naples*, I found it there near the Rocks, and in some wild solitary Places like a Native. If the *Spaniards* planted it, they chose desert Situations. On this Plant the *Cochineal*

*Verm*



*Vermiculus* is said to feed in great Numbers, before it changes into the *Chrysalis* or *Aurelia* of a *Lady-Com* : but the Colour lies in the *Nymph-Worm* before it turns a *Beetle*. This gives me occasion to reflect upon the many Species of our *European Vermiculi*, some of which might be found to yield rich Colours (if try'd) : We are certain the Maggot of our *Ilex* gives the *Kermes*, and a noble Scarlet Dye before it turns into a Fly. Many Shell-Fish (which are a sort of Insect) contain Purple Juices.

This brings on another Remark I made in passing the *Apennines* and *Alps*, where I noted in some Beds or *Strata*, and even in the midst of the hardest Rocks, great varieties of perfect Shells, that never occur'd to me on the *Italian Shores*, nor in any of the numerous *Museums* of that Country : so I guess they might be *Exotick*.

Going further on the *Via Appia*, I observ'd abundance of the *Siliqua Arbor* or *Carob Tree*, commonly call'd *Panis S. Joannis Baptista* ; on the Pulp whereof many poor People were feeding. The Husks tasted like *Manna* to me. Near them grew plenty of the *Arbor Jude*.

The *Arbutus*, or *Strawberry Tree*, was common in the woody places ; if this grows wild in the South West parts of *Ireland*, as some affirm, I shall think them much warmer than any Counties of *England*.

Before I enter'd the beautiful *Campania* of *Naples* large Woods of *Cork Trees* grew on each side the Road, where the Inhabitants were decortivating them. I ask'd if the Trees did not perish : they answer'd, some did, but the Acorns return'd annual Supplies. The Women and Children wore Shoes made of the Bark.

Coming near *Capua* I observ'd a Species of Ash, or *Ornus*, on the Trunk whereof many Saccharin Concretions were visible. This prov'd the true *Manna*, that issues out thro' the Incisions made in this Tree by the Inhabitants of *Calabria*. Swarms of *Cicada's* were sucking the  
Body

Body and Boughs, and perhaps by wounding then made way for fresh *Manna*. Here I may note, that many Insects have not only a *Proboscis* to bore and draw out the Juices of Plants for Aliment, but other proper Instruments to convey their Eggs into Vegetables and Animals, where they may find Covert and Food when they come to hatch, in the Gall-Tumours, and other Excrescences occasion'd by the Wounds of the Parent Insects, that make such variety of *Cuniculi* in all parts of Plants, and even in the cutaneous parts of living Creatures and in dead Flesh.

This confirms me, that many Gums and Exudations find their way out of Vegetables thro' the Wounds of Insects and other Apertures. Most *Voyagers* thro' the *East Indies* affirm, that *Gum Lack* is work'd and made by large *Ants* that cover the Trees. I rather think the Insects suck and terebrate the Tree, and so give vent to that peculiar Sap that hardens in the Sun. This may extend to most Balsamiferous, Gummiiferous, and Saccharine Plants, especially in hot Climates where Insects abound, and are more active. In cold Climates the Saps of many Vegetables will boyl into Sugars, as that of Maple, Birch, Reeds, &c. Not but that the Fluids of Plants (like those of Animals) will spontaneously break thro' their Vessels in a Plethory, and make on the superficial Parts various Eruptions and Congestions.

Discourſing of *Manna* I may here take Notice there are many adulterations of this Drug: all paſſes for the *Calabrian*, whereas that of *Brianſon* is from the *Larix*, that of *Persia* from the *Myrica*, and theſe frequently mixt with the Juices of Spurges, and other Purgative Ingr-dients. I muſt not here deny that Dew will ſometimes in cool Mornings ſhoot, and congeal into a ſolid, ſweet, white Subſtance, which I once obſerv'd in very hot Weather before Sun-riſe.

Upon viewing the *Vulcano's* about *Naples*, *Vesuvius* on the East side, the *Solfatara* and *Monte di Cinere* on the West near *Puzzuolo* and *Bajæ*; I observ'd the same Face of Nature, which I believe runs thro' all the other *Vulcano's* of our Globe, viz. heaps of Pumice Stones and Cinders of *Marchasites* on the sides, with Beds of Flower of Brimstone on the tops. The Holes and Cavities in those calcin'd Minerals seem to be the *Nidus* of the *Sulphur*, which hath been sublim'd by the Heat and Fire of that vast Mass of *Pyrites*, that compose the Bowels of those *Vulcano's*, and lye scatter'd thro' many parts of the Earth, even under the Sea, where they sometimes germinate, ferment, and take Fire, throwing up little *Islands*. Earthquakes and other *Chor's* of the Globe may spring from the Mines of these combustible and explosive Minerals, loaden with Brimstone and Elastic Salts. Hence some Account may be given of *Therma* or hot Baths, whose Waters gliding thro' these hot Beds take their Gas. Of such Medicinal boiling Waters and Stoves, there are more about *Naples* than in any place I ever saw or heard of, the whole Country being continually pervaded by hot Steams.

Walking round this City I found *Palm Trees*, some with unripe *Dates* hanging down, others without any Fruit: and there was another Species of *Palm* that sweats out the *Gum Dragon*: I suppose the Monks had transplanted them out of *Africa*. I saw growing here many *Sugar-Canes*, *Rice*, *Maiz*, abundance of the purging *Senna*, and *Cummin Seed*. Thro' the whole *Campania* of *Naples* I observ'd the same Vegetables to be larger and more proud than in other parts of *Italy*, as the *Platanus*, the *Lentiscus*, the *Terebinthus*, the *Pistaches*, the *Oleanders*, *Agnus Castus*, *Barba Jovis*, the *Tragacanth*, the *Styrax*, the *Capers*, &c. The *Melons*, *Jujubes*, the *Azaroles*, and other Fruits were of a better Taste. The *Gossypium*, with the Cor-

ton breaking out of the husks, adorn'd some of the Fields; the Hedges full of *Pomegranats*, *Almonds*, *Tamarisk*, *Sumach*, *Cedrus Lycia* (a sort of Juniper or Savin) abundance of *Phillyrea*, *Alaternus*, *Cisti*, *Cytisi*, *Myrtles*, *Spanish Broom*, *Bays*, *Laurustines*, &c. all wild, Indigenous of that warm Soil and kind Climate. The Water-Melons, the Olives, the Oranges, Lemons and Citrons were better than about *Genoa* or in *Provence*.

The *Lotus Arbor* or *Nettle Tree*, the *Paliurus* or *Christ Thorn*, the *Ricinus* or *Palma Christi*, common in the Hedges, with several *Thymelea's*.

I saw them fishing for *Coral*, and *Hippocampi*: the first did not come soft out of the Sea; the hard Incrustation covers the Vegetable part that bears Seed, as the *Alga's* and *Fuci* do. They take the *Sword-Fish* by darting a Spear into him, as they do the *Whales* in the *Greenland* Fishery.

When dark Night came on, I could see Multitudes of Luminous Flies thro' the *Campania* of *Naples*: perhaps our Male *Gleworm*, or flying *Cicindela*, may abound there; not but that many other Insects may carry such Lanthorns about them. The *Scorpions* creep out about that time; and I have found them often in Bed, with the *Punaises*.

The Hedges are full of *Lizards* of various Colours; and the *Cicada's* chirp and sing towards Evening. I observ'd several Species of stinging Spiders in the Corn Fields, some of which, in hot Harvests, may prove *Tarantula's*; the Poys'ons of Animals and Plants increasing with the approach of the Sun, and the Heats of Climates. Abundance of Silk-Worms were spinning on the Trees and Shrubs; the Birds prey'd upon them, before they could change into *Papilio's*, as they do upon swarms of *Locusts*.

I eat often their young Frogs, Tortoises and Snails, served up with Oyl and Pepper, which agreed well with me : so did their *Sea Urchins*, and the *Urtica Marina*, (called *Sea Gelly* or *Blubber*, tho' it be an Animal, having a true Heart, and Vessels for the Circulation of Fluids) Some of their Thistles are no ungrateful Sallet.

I saw some Vitriol Works about *Siena*, *Rome* and *Puzzuolo*; those of *Alum* only about *Civita Vecchia*. Amongst the Sands of the *Adriatic* Sea I observ'd many white, clear, shining Flints; which they told me were carried to *Venice*, to make the fine Chrystal Glafs at *Muran*.

Upon reading our ingenious Dr. *Musgrave*, de *Geta Britan. & Synop. Chronolog. Dom. Sever*. I consulted my Diary taken at *Rome*. The Magnificent *Septizonium* figur'd by him stood near the Foot of the *Palatine* Hill, on the *E.S.E.* side, overlooking the *Via Appia* and the *Circus Maximus*, the *Amphitheatre* of *Titus* being near on the other Side. By the number of *Portico's* (which were Seven) it might contain Multitudes of People, as Spectators of the Triumphal Entries and the publick Games. But I would not be thought to differ from our *Learned Countryman*, who with good Authority, thinks it the *Sepulchretum* of that Imperial Family; tho' most of the Ancient *Mausoleum's*, (at least those I saw) were *Rotunda's*, or *Columbaria's*, for the more convenient placing the *Urns* of the Kindred; as that of *Augustus* near the *Campus Martius*; that of *Adrian* on the other Bank of the *Tyber*; those said to be of *Scipio*, of *Cicero*, and *Munatius Plancus*, near *Gaeta* and the *Via Appia*; that of *Virgil* on the side of Mount *Paufilippus*; that of *C. Metella* and some others on the *Via Flaminia*. Some were Pyramidal as that of *Cestius* in the Wall of *Rome*, and a few others on the public Roads. This *Septizonium Severi* seems to differ from the rest of those Ancient *Sepulchretum's*, which  
might

might be varied according to the Fancy and Humour of great Families.

This Urn Burial was only in Fashion amongst the *Gentes Majores* : as for the dead Bodies of the *Plebeians* and Slaves, they were generally laid in places where they had dug Stone ; and those Quarries became *Catacombes*. The Laws prohibited them to bury within a City, unless the Bodies were first reduc'd to Ashes.

I observ'd in many of the Ruins about *Rome* and *Naples*, great Stones laid close, and wedged very fast with little or no Cement ; the Bricks, towards the middle of a Building, were generally of a *Rhomboidal* Figure, very Smooth, Shining and Hard, laid in Plaister as firm as Marble. Their Mortar was much more durable then ours, as appears at this Day by their *Aqueducts* and *Piscina's*, the *Cento Camare*, and *Caligula's* Bridge under Water at *Baja*. *Pliny* says, they made use of the *Terra Puteolana*, but the present Inhabitants have lost the way of tempering it.

During my abode at *Genoa*, *Leghorn*, *Ostia* and *Civita Vecchia*, I observ'd many *Torpedo's* or *Cramp Fishes*, most accurately Anatomized by *S. Lorenzini* ; plenty of *Sphyrana's*, (a Species of Sea Pike, a-kin to the Needle Filhes) The *Uranoscopus*, call'd *Bocca in Capo* and *Prete*. The *Mola* or Sun Fish. The *Dentex* or *Pentalis*, *Altaveli's* a sort of *Pastinaca*. The *Pesce Balestra* or *Capriscius*. The *Pesce Pettine* or *Novacula*. The *Zygana* or Ballance Fish, as large as the Saw-Fish or most Sharks. The *Scolopax* or *Trombetta*, call'd by our Seamen the Bel-lows or Trumpet-Fish. The *Draco Marinus*. The Tun-ny-Fish. The *Centrina* or *Pesce Porco*. The *Aquila*. The *Scorpius Major*, with Varieties of *Turdi* in the Markets. But what pleas'd me most, were some odd Sea Ani-mals, as the *Lepus Marinus*, (a Species of naked Snail) the *Hystrix Marinus*, or *Eruca*, call'd by the Seamen *Pincio*, with a Brush hanging out of the Tail, like the *Byssus* or

Silk of the *Pinna*. Many *Tamburo's* or Drum-Fishes; Plenty of *Murena's*. I observ'd a strange Sea Animal, call'd the *Microcosmo marino*, with many Shells, *Tubuli* and Vegetables growing or sticking to the Back of it, this appear'd to me a-kin to the *Echini Marini*, or rather to the *Stellæ Marinae*, being Triangular, and sometimes *Pentadactylous*.

I embark't once with the Fishermen, who shew'd me several *Loligo's*, *Polypi*, and *Sepia's*, or Cuttle-Fishes, (all *Crustaceous*) some of them were casting out their Ink in the Water: I supposed some Sharks, Dog-Fishes, or other Enemies, were near them; this black Liquor may be the Gall of those Animals. In the Nets, I often found Sea Insects, and Vegetables; and indeed a new World, undescrib'd by natural Writers, at least unknown to me: but for want of the Art of Designing or Drawing, abundance of things escap'd me, and were utterly lost; therefore I would advise all Travellers to be conversant in that most useful Science.

I observ'd the *Italians* near the *Alps* and *Appennines*, call'd several Birds *Francolino's*, as our Red, Grey and Black Game; and even their red and white Partridges; the different Colours of the Hens from the Cocks, the many Variegations in Feathers, the different Ages and Places, have all given occasion to multiply Names and Species; the same may happen in Fishes, Quadrupeds, Insects, and all the Divisions of *Zoology*; and even in *Botany* and *Minerology*.

The *Italians* call many of their little fat Birds *Beccafico's*, that feed upon Figs, Grapes, and other sweet Fruits. So the *French* multiply their *Ortulans*, taken in the Vineyards and Gardens. Some of the Antient Writers take Notice that the *Romans* us'd to feed their Geese and other Birds with Figs, when they intended to swell their Livers to a monstrous Bigness.

The

The *Merops* or *Apiaster* is common on their Brooks; it flies like our Kings-Fisher, and preys not only upon Insects but Fish. There is a very beautiful Bird in *Italy*, that suspends its Nest down from the Boughs of Trees. When I saw it fly by me, I took it for an *Indian*, from the brightness of its Colours; it is as large as our Missel-Bird and Thrush. *an Icterus Plinii?*

The great *Cock of the Wood* (said to be found in *Ireland*) is common on the sides of the *Italian Hills*, and brought frequently to the Markets. I saw twice or thrice the *Himantopus*, and the *Phenicopterus* or *Flamingo*, (whose Tongue was a Dainty amongst the *Romans*, when they grew Luxurious). I observ'd some *Spoon-bills*: these three last Birds were wading in the Rivers and Marshes, near the Sea. Once I spy'd some *Peleicans* on the *Adriatic*, near the mouth of the *Po*. The *Avis Diomedea* was hung up dry'd in one of the *Museums* at *Florence*, but they told me it had been taken on some of the Isles of the *Archipelago*.

On the *Laguna of Venice*, I saw several Species of *Mergi*, *Lari*, *Colymbi*, and other Water Fowls, most of which Div'd. I was surpriz'd with the Variety of them, having not seen so many on other Coasts: perhaps the hard Winter had forc'd some unusual Birds thither. The Monks and Fryers told me, they eat some of those Sea Birds in *Lent* and on Fast Days, because they liv'd upon Fish, and had a piscose Taste, as the *French* pretend their *Macreuse* to have. which is a sort of Sea Duck, common on the Coast of *Normandy*, and brought to the Markets, even at *Paris* on *Maigre Days*; of which I gave a long History in the *Philos. Transact. An. 1685. N<sup>o</sup>. 172.*

*Buffaio's* are common in the Kingdom of *Naples*, and in some parts of *Lombardy*, where they plough and draw  
with



with them. A peculiar Cheese is made of their Milk (call'd *Casio di Cavallo*) rowl'd up like stiff pieces of Ribbon. Out of their black shining Horns they make Snuff-boxes and Combs. The Creature is unruly, and therefore they lead them with Iron or Brass Rings drawn thro' their Noses. They make a Buff Leather of their Skins. I once saw some hairy Sheep-feeding on a Common; perhaps they had been brought from *Africa*.

In passing the high *Alps*, I had a View of the *Ibex* or *Steinhock*, whose large Horns are recurvated almost as far back as the Tail; they are very ponderous for the bulk of the Animal, having many knotty Rings, that may help them in climbing. They are rarely taken.

The *Rupicapra* or *Chamois*, is very common on the sides of the Cliffs, whose Skins afford the soft Leather. The *Mus Alpinus*, or *Marmota*, is as large as a Rabbit, will soon grow tame in Houses, tho' brought down from the Summits of the highest Mountains, where it will grow fat.

I have seen in several Towns of *Italy* fresh strong *Porcupines*, which the Inhabitants told me were taken in the Hedges and Ditches thereabouts, tho' much more rare than our Land *Urchins*. In the *Grisons* Country, and in some Cantons of *Switzerland*, I have often observ'd the *Ranunculus Viridis* or small Tree-Frog, perching on the Boughs and Leaves.

In the Northern Parts of *Germany* I saw several *Elk-Skins*, and those of the *Rhin-Deer* stuffed, and set up in *Museum's*, but never alive: tho' the Animals are said to be common in *Muscovy* and *Lapland*; and sometimes seen in the Forests of *Prussia*.

The Skins of *Hippopotami* (said to be the *Behemoth*) are in some Collections of Curiosities in *Italy* and *Holland*: so are those of the *Musk-Deer*, one of which is in the *Museum* of our *Royal Society*.

Give

Give me leave here to reflect a little upon the late *Aurora Borealis*, whose *Phænomena* you have so well describ'd and explain'd in your late *Philosophical Transactions*, No 347. I am of your Opinion, that these Phosphorous or Luminous Appearances in the Firmament, proceed from the various *Effluvia* perspir'd out of our Globe, or passing thro' it; for I have seen those Lights over *Vesuvius*, the *Strombulo* Islands, and towards *Bina* in dark Nights, when those *Vulcano's* were not smoking nor burning, their Sides and Tops being passable to Travellers at that time, and all their outward parts quiet. We are certain that *Iceland* and *Greenland* abound with *Vulcano's*; so may North East *Lapland*, North *Russia* and *Tartary*, where vast Chains of Mountains are said to run. The *Jesuits*, and other Travellers, relate many prodigious Eruptions of Fires, and Earthquakes towards the North of *China*; but nearer the Pole the Earth must be clos'd and pent up many Months, by the long severe freezings and continual Snow and Ice, which relaxing towards Spring, may give vent to that vast Mass or Magazine of perspirable Matter, that had been kept so long in hot Subterraneous Prisons. This may be one Reason why Animal Bodies themselves are often sensible of Changes at that Season in our Climate, when Perspiration is upon such an Increase; but I will not take up your time any longer, especially upon a Subject that you understand so well.

S I R,

Your most humble Servant,  
Tancred Robinson.

IV *An Account of the Mischiefs ensuing the swallowing of the Stones of Bullace and Sloes. By the Reverend William Derham, Prebend of Windsor, and F. R. S.*

**A**Mong the Accounts which the Royal Society hath had of the Mischiefs ensuing the swallowing of divers sorts of Stones, I do not remember any Case wherein the lesser Stones of Fruits (such as *Sloes* particularly and *Bullace*) have produced any dangerous Symptoms, especially in the Stomach alone. The larger Stones, I know, of *Prunes*, and other great *Plumbs*, have produced very fatal Effects ; but the lesser Stones of *Sloes*, *Cherries*, &c. many swallow rather out of choice, than with any apprehensions of Danger, thinking them useful in preventing a Surfeit from the Fruit. But the following Case will shew the Danger even of these lesser Stones. And I have acquainted the Society with it, on purpose to prevent Dangers, if it should be thought fit to publish it in the *Transactions*, for a warning to others.

The Case is this. About two Years ago the Man-Servant of a Neighbouring Clergyman complained to me of excessive Pains in and about his Stomach ; that he lay under a great Dejection of Appetite ; and whenever he eat, that he could not retain it, but in a little time vomited it up. By which means he was, in a short time, reduced to a very low and languishing Condition, in-somuch as they began to despair of his Life.

Upon this he applied himself to some Practitioners in Physick : One of which ply'd him with strong Vomits  
eight

eight Days together, with very little Signs of Success. But some time after, having Occasion to ride somewhat more than ordinary, he found himself very sore in his Stomach, and Sick ; which ending in violent Vomiting and Straining, brought up the first Stones he ever perceived to come from him, which were about Twenty in number:

After this he had frequent returns of the Vomiting up of *Bullace* and *Sloe-Stones*, especially upon strong Exercises ; particularly moving and stooping much in Weeding in the Garden ; in Riding also, although it was only to water his Master's Horse. Upon these Occasions he would be seized with acute Pains in his Stomach, and soon after Vomit up more of those Stones.

He hath counted above One hundred and twenty *Bullace* and *Sloe-Stones* that have been discharged ; and many others he could not number, by reason they came up when he was in Riding or in his Business. He is not yet free of them, but is in Pain oftentimes, and Vomits them up, especially in Riding ; but after he hath discharged them, he is much easier for a while. He commonly brings up a slimy Matter with them, mixed with Blood or something very like Blood.

The Cause of all this Disaster the Man assures himself was this, namely, being in his Youth a great lover of Fruit, he used greedily to devour all sorts he could come at, and *Bullace* and *Sloes* being the easiest to be gotten, he used to ingurgitate great quantities of them, without evacuating many of the Stones by Stool, as he well remembers, and as he observed others did. These Stones he thinks have lain in his Stomach (some of them at least) above ten Years ; but he felt no Pains till about four Years ago. And those at first were not so violent, nor attended with such severe Fits of vomiting, and

loss of Appetite, as they by degrees came to be afterwards.

Thus having related the Case as the Man told it me, I shall leave the *Ætiology* of it to the learned Physicians, it being sufficient for me to relate the matters of Fact, and thereby testify the Duty and Respects owing to the Society by

*Their most obedient*

*Humble Servant,*

W. Derham.

V. *Observations and Experiments relating to the Motion of the Sap in Vegetables.* By Mr. Richard Bradley, R. S. S.

OF Plants in general we may first observe, that they are either *Terrestrial*, *Amphibious*, or *Aquatick*; and so nearly do Vegetables agree with Animals in most points, except Local Motion and its Consequences, that from the Knowledge of the one we are reasonably led to the Discovery of the other.

Those Plants which I call *Terrestrial* are such as *Trees*, *Shrubs* and *Herbs*, which grow only on the Land. These like Land Animals have diversities of Food, a Method of Generating, and certain Periods of Life.

Of the *Amphibious* race, which live as well on Land as in the Waters, are the *Willows*, *Rushes*, *Mints*, &c. these are not unlike in many respects to the *Otter*, *Tortoise*, *Frog*, &c.

The *Aquaticks*, whether of *Lakes*, *Rivers*, or the *Sea*, are very numerous; these may be compared with the Fish-kind, and like them will not live out of their proper

per Element. In *Fresh Waters* are the *Water-Lilly's*, *Plantains*, &c. and in the *Sea*, *Corals*, *Fuci*, &c.

*Plants* seem to possess only the next degree of Life below the most stupid *Animal*; or where *Animal Life* leaves off the *Vegetable Life* seems to begin.

The Seasons of Motion in *Plants* are the same with those of *Animals*, which sleep during the Winter. An Artificial Heat will give Motion to either of these in the Coldest time.

The common Opinions relating to the *Saps* Motion are as follows. First, The *Sap* does not rise by the *Pith*; because some have observ'd the Trunks of large Trees to be without that part, and yet the same Trees have continued to put forth Fruit, and Branches on their Tops. I have observ'd, that the *Pith* is not found in those Branches of a Tree which exceed two or three Years growth; and it is certain, that the *Pith* which is in a Branch of this Year, will (the greatest part of it) be distributed into those Boughs which form themselves the next Season.

It is said by some, that the Tree does not receive its Nourishment by the *Bark*, for that Trees having lost that part, will still continue their Growth. Others tell us, that if the *Bark* be cut away round the Trunk of a Tree, it will presently die. These various opinions seem to have been set on foot without extraordinary Consideration, upon the belief that a Tree has but one *Bark*: Whereas, upon Examination with the Microscope, we find four distinct Coverings to each Branch, without the woody parts. The two outermost *Barks* may be taken from a Tree without great Damage, but the other two which lye nearer the Wood being strip'd off will kill the Tree.

Some affirm, that the *Sap* doth neither rise nor fall in the woody part of a Tree, because they have not been

able to discern any *Sap* to issue out of that part, when a Branch has been cut. The Microscope plainly shews us the Vessels in the Wood, through which the *Sap* riseth from the Root; but as these Tubes are not large enough to admit into them any thing more gross than Vapour, so they have not been esteem'd to be of any great Use. But I hope the Explanation of the adjoyn'd Figure will in some measure discover the Office of these, and of such other parts of a *Plant* as are severally design'd for the Growth of Vegetables; but it will first be convenient to enquire a little into the Nature of the *Root*.

The *Root* of a Tree is chiefly compos'd of a *Parenchyma*, more gross than that in the Stem or Body of the Tree; it has likewise Vessels and a Covering, which I shall better explain in another Paper. The Root, that is, the principal part of it, receives into it such Juices of the Earth as are proper for it, and no other. Somewhat like a Weck of Cotton, which having been impregnated with Oil, will only admit Oil into it. This Provision being made in the *Stomach* of the *Plant* (as I call it) chiefly in the Autumn Months, the Tree is prepared for Germination so soon as the Earth is sufficiently warm'd, either by the Sun's Beams, or an artificial Heat, such as Horse dung, Bran and Water, or other such like Ferments. These Heats raise into Vapour the Juices contained in the Root, and by that means cause Vegetation.

*Figure I.* which I am about to explain, is part of the Branch of an *Apple Tree* made in *May 1715*, and cut in *April 1716*. It was cut in figure of a half-Cylinder, the length somewhat more than the Diameter, which was about a quarter of an Inch. This being magnified with one of *Campani's* Microscopes, discovers the following parts, *viz.*

1, 2, 3, 4, 5, 6, 7. are Capillary Vessels, which run longitudinally through the Branch, in the Ligneous part, which was made in the Year 1715. Through these Tubes, the Steam riseth from the Root; the strength of which is well explain'd by the Engine for raising Water by Fire, invented by the late Captain *Savory*.

From A to B, we may view Vessels of the same sort, made at the same time.

8, 9. are Vessels of the same use with the former, now forming themselves for the use of the Year 1716.

By this means the Diameter of the Branch is increas'd, and additional Nourishment suffer'd to pass into those Buds which are to make new Branches. These are made out of the Fourth or innermost Bark, markt C, C.

The Mouths of the Capillary Tubes of the Years 1715, and 1716. are D, E. The Vapour which riseth from the Root, is continued in these Vessels, to the extremities of the Branches; where it meets with parts (not here describ'd) like to *Glands*; which *Glands*, if we may so call them, are likewise found at every Knot or Joynt. At these places, the Vapour coming near the Air is condensed, and returns between the Barks, by means of its own weight, down F, G, H, leaving in each Bark mark'd I, K, L, such Juices as each of them naturally is inclin'd to separate from it; till at last, the more Oily part passing to the Root, may lengthen the *Fibres* thereof, as Icicles are lengthned; and by its Oleous Particles, preserve them from Rotting by the Wet. The parts which compose the several Barks, are *Parenchymous* or *Spongy*.

The first mark'd M, is of a closer Texture than the second N, and the second closer than the third O, and so on till these *Parenchymous* Parts are interwoven with the longitudinal Wood-Vessels, where they are somewhat constrain'd, till they come to make the Pith mark'd P. Then they are much Larger than in any  
other



other part of the Tree; and by what I have observ'd, seem to contain a more finish'd Juice than the rest, and may well enough be stiled the *Medulla*.

We may note, that when the fourth or innermost Bark C, has once compleated its Sap-Vessels, and is firmly join'd to the Wooden Part, then the third Bark O takes its place for the succeeding Year; and so the rest, except that the first mark'd M, splits and divides its self, to supply the place of the second, as I shall demonstrate hereafter.

Before I conclude, I shall beg leave to recommend the following Enquiry to the Curious, *viz.*

If the several Barks, having different Texture of Parts, admit into each separate and different Juices from the rest: Whether those Juices may not be of very Different Vertues; the first more *Astringent* than the others, the second perhaps *Emetick*; and the third *Cathartick*. This seems to be worth Enquiry.

VI. *Some Microscopical Observations, and Curious Remarks on the Vegetation, and exceeding quick Propagation of Moldiness, on the Substance of a Melon. Communicated by the same.*

I Had lately a large Melon-Fruit, which I split lengthways thro' the Middle, in order to observe the Vessels which compos'd the Membrane or Tunick of each Ovary; but my affairs at that time not permitting me to continue the Work I had began, I lay'd by the one half of the Melon, to be examin'd when I might have more Leisure.

At

At the end of four Days, I found several Spots of Moldiness began to appear on the fleshy Part of the Fruit, somewhat Green towards the Rind; and of a paler Colour towards the Middle of the Fruit. These Spots grew larger every Hour, for the space of five Days; at which time the whole Fruit was quite cover'd.

This surprising Vegetation made me Curious to examine, if there was any difference between those Parts which were Green and the others, besides their Colour. The first being seen with the Microscope, appear'd to be a *Fungus*, (See Fig. 2.) whose Cap was fill'd with little Seeds, to the number of about Five Hundred; which shed themselves in two Minutes after they had been in the Glasses.

The other Sort had many Grass-like Leaves, among which appear'd some Stalks with Fruit on their Top. Each Plant might well enough be compared to a sort of *Bull-Rush*, (Fig. 3.) They had their Seed in great Quantities, which I believe were not longer than three Hours before they began to Vegetate; and it was about six Hours more, before the Plants were wholly perfected: for, about seven of the Clock one Morning, I found three Plants at some Distance from any others; and about four the same Day, I could discern above Five Hundred more growing in a Cluster with them, which I supposed were Seedling-Plants of that day. The Seed of all these were then Ripe and Falling.

When the whole Fruit had been thus cover'd with Mold for six Days, this Vegetable Quality began to abate, and was entirely gone in two Days more. Then was the Fruit putrified, and its fleshy Parts now yielded no more than a stinking Water, which began to have a gentle motion on its Surface, that continued for two Days without any other Appearance. I found then several small Maggots (Fig. 4.) to move in it, which  
grew

grew for the space of six Days; after which they laid themselves up in their Bags. Thus they remain'd for two Days more without Motion, and then came forth in the Shape of Flies. (Fig. 5.) The Water at that time was all gone, and there remain'd no more of the Fruit than the Seeds, the Vessels which compos'd the Tunicks of the Ovarys, the outward Rind, and the Excrement of the Maggots; all which together weigh'd about an Ounce. So that there was lost of the first weight of the Fruit when it was cut, above twenty Ounces.

We may Judge from this, and other Cases of the like nature, how much Vegetable Life is dependent on Fermentation, and Animal Life on Putrification.

VII. *The Art of Living under Water: Or, a Discourse concerning the Means of furnishing Air at the Bottom of the Sea, in any ordinary Depths.*  
By Edm. Halley, LL. D. Secretary to the Royal Society.

There have been many Methods propos'd, and Engines contriv'd, for enabling *Men* to abide a competent while under *Water*: And the Respiring fresh *Air* being found to be absolutely necessary to maintain Life in all that breath, several ways have been thought of, for carrying this *Pabulum Vita* down to the *Diver*, who must, without being somehow supplied therewith, return very soon, or perish.

We have heard of the *Divers* for Sponges in the *Archipelago*, helping themselves by carrying down *Sponges* dipt in Oyl in their Mouths: but considering how small a Quantity of *Air* can be suppos'd to be contained in

Fig. 1.

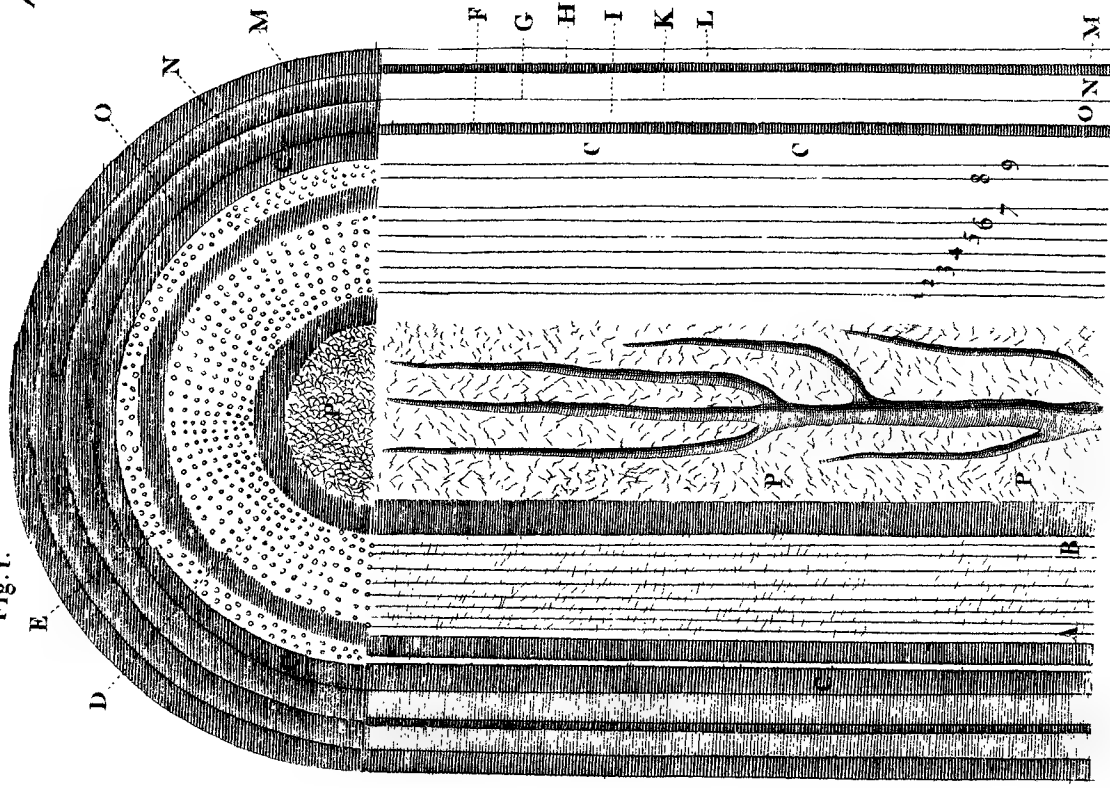


Fig. 2.

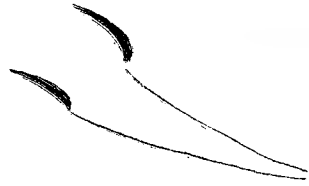


Fig. 3.

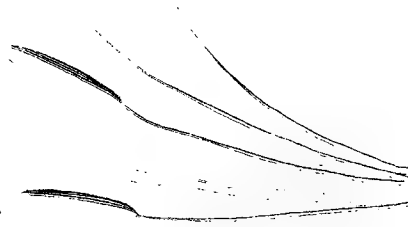


Fig. 4.



Fig. 5.



the Pores or Interstices of a *Sponge*, and how much that little will be contracted by the Pressure of the *incumbent Water*, it cannot be believed that a Supply, by this means obtained, can long subsist a Diver. Since by Experiment it is found that a *Gallon of Air*, included in a *Bladder*, and by a Pipe reciprocally inspired and expired by the *Lungs* of a Man, will become unfit for any further Respiration, in little more than one Minute of Time; and though its Elasticity be but little altered, yet in passing the *Lungs*, it loses its *vivifying Spirit*, and is rendered effete, not unlike the *Medium* found in *Damps*, which is present Death to those that breath it; and which in an instant extinguishes the brightest *Flame*, or the shining of glowing *Coals* or red hot *Iron*, if put into it. I shall not go about to shew what it is the *Air* loses by being taken into the *Lungs*, or what it communicates to the *Blood* by the extream ramifications of the *Aspera Arteria*, so intimately interwoven with the *Capillary Blood-Vessels*; much less to explain how 'tis performed, since no discovery has yet been made, to prove that the ultimate Branches of the *Veins* and *Arteries* there, have any *Anastomoses* with those of the *Trachæa*; as by the *Microscope* they are found to have with one another. But I rather choose to leave this Enquiry to the Curious *Anatomist*, to whom the Structure of the *Lungs* is better understood; and shall only conclude from the aforesaid Experiment, that a naked Diver, without a *Sponge*, may not be above a couple of Minutes enclosed in Water, (as I once saw a *Florida-Indian* at *Bermudas*) nor much longer with a *Sponge*, without Suffocating; and not near so long without great Use and Practice: ordinary Persons generally beginning to stifle in about half a Minute of Time. Besides if the Depth be considerable, the pressure of the *Water* on the Vessels is found by Experience to make

the Eyes Blood-shot, and frequently to occasion spitting of Blood.

When therefore there has been occasion to continue long at the *Bottom*, some have contrived double flexible Pipes, to circulate *Air* down into a Cavity enclosing the *Diver* as with Armour, to bear off this pressure of the *Water*, and to give leave to his Breast to dilate upon *Inspiration*: the fresh *Air* being forced down by one of the Pipes with *Bellows* or otherwise, and returning by the other of them; not unlike to an *Artery* and *Vein*. This has indeed been found sufficient for small Depths, not exceeding twelve or fifteen Foot: but when the Depth surpasses three Fathoms, Experience teaches us that this Method becomes impracticable: for though the Pipes and the rest of the *Apparatus* may be contrived to perform their Office duly, yet the *Water*, its weight being now become considerable, does so closely embrace and clasp the Limbs that are bare, or covered with a flexible Covering, that it obstructs the Circulation of the *Blood* in them; and presses with so much force on all the Joints, where the *Armour* is made tight with *Leather*, *Skins* or such like, that if there be the least defect in any of them, the whole Engine will instantly fill with *Water*, which will rush in with so much violence, as to endanger the Life of the Man below, who may be drown'd before he can be drawn up. Upon both which accounts, the danger encreases with the Depth. Besides a Man thus shut up in a weighty *Case*, as this must needs be, cannot but be very unwieldy and unactive, and therefore unfit to execute what he is designed to do at the Bottom.

To remedy these Inconveniences, the *Diving-Bell* was next thought of; wherein the *Diver* is safely conveyed into any reasonable Depth, and may stay more or less time under *Water*, according as the *Bell* is of greater or lesser Capacity. This is most conveniently made in form  
of

of a *Truncate Cone*, the smaller *Basiss* being closed, and the larger open: and ought to be so poized with *Lead*, and so suspended, that the Vessel may sink full of *Air*, with its greater or open *Basiss* downwards, and as near as may be in a situation parallel to the *Horizon*, so as to close with the Surface of the Water all at once. Under this Couvercle the Diver setting, sinks down together with the included *Air* into the Depth desired; and if the Cavity of the Vessel may contain a Tun of *Water*, a single Man may remain therein at least an Hour, without much inconvenience, at five or six Fathoms Deep. But this included *Air*, as it descends lower, does contract it self according to the weight of the Water that compresses it; so as at thirty three Foot deep or thereabouts, the Bell will be half full of Water, the Pressure of it being then equal to that of the whole Atmosphere: and at all other Depths, the space occupied by the compressed *Air* in the upper part of the *Bell*, will be to the under part of its Capacity fill'd with Water, as thirty three Feet to the depth of the Surface of the Water in the Bell below the common Surface thereof. And this condensed *Air*, being taken in with the Breath, soon insinuates it self into all the Cavities of the Body, and has no sensible effect, if the Bell be permitted to descend so slowly as to allow time for that purpose. The only inconvenience that attends it, is found in the Ears, within which there are Cavities opening only outwards, and that by Pores so small as not to give admission even to the *Air* it self, unless they be dilated and distended by a considerable Force. Hence on the first descent of the Bell, a Pressure begins to be felt on each Ear, which by degrees grows painful, like as if a Quill were forcibly thrust into the Hole of the Ear; till at length, the force overcoming the Obstacle, that which constricts these Pores yields to the Pressure, and letting some condensed *Air* slip in, present Ease ensues.

But the Bell descending still lower, the Pain is renewed, and again eased after the same manner. On the contrary, when the Engine is drawn up again, the condensed Air finds a much easier Passage out of those Cavities, and even without Pain. This Force on the auditory Passages might possibly be suspected to be prejudicial to the Organs of Hearing, but that Experience teaches otherwise. But what is more inconvenient in this Engine, is the Water entring into it, so as to contract the bulk of Air (according to the aforesaid Rule) into so small a space, as that it soon heats and becomes unfit for Respiration, for which reason it must be often drawn up to recruit it: and besides the Diver being almost covered with the Water thus entring into his Receptacle, will not be long able to endure the Cold thereof.

Being engaged in an Affair that required the Skill of continuing under Water, I found it necessary to obviate these Difficulties which attend the use of the common Diving-Bell, by inventing some means to convey Air down to it, whilst below; whereby not only the Air included therein, would be refresh'd and recruited, but also the Water wholly driven out, in whatever Depth it was. This I effected by a Contrivance so easy, that it may be wondred it should not have been thought of sooner, and capable of furnishing Air at the bottom of the Sea in any quantity desired. The description of my *Apparatus*, take as follows.

The Bell I made use of was of Wood, containing about 60 Cubick Foot in its Concavity, and was of the form of a Truncate-Cone, whose Diameter at Top was three Foot, and at Bottom five. This I coated with Lead so heavy that it would sink empty, and I distributed the weight so about its bottom, that it would go down in a perpendicular Situation and no other. In the Top, I fixed a strong but clear Glass, as a Window to let in the  
Light



Light from above; and likewise a Cock to let out the hot Air that had been Breathed; and below, about a Yard under the Bell, I placed a *Stage* which hung by three Ropes, each of which was charged with about one Hundred Weight, to keep it steady. This Machine I suspended from the Mast of a Ship, by a *Spritt* which was sufficiently secured by *Stays* to the Mast-head, and was directed by *Braces* to carry it over-board clear of the Ship side, and to bring it again within-board as occasion required.

To supply Air to this Bell when under Water, I caused a couple of Barrels, of about 36 Gallons each, to be cased with Lead, so as to sink empty; each having a Bung-hole in its lowest Part to let in the Water, as the Air in them condensed on their descent; and to let it out again, when they were drawn up full from below. And to a Hole in the uppermost Part of these Barrels I fixed a Leathern Trunk or Hose, well liquored with Bees-Wax and Oyl, and long enough to fall below the Bung-hole, being kept down by a Weight appended; so that the Air in the upper Part of the Barrels could not escape, unless the lower ends of these Hoses were first lifted up.

The Air-Barrels being thus prepared, I fitted them with Tackle proper to make them rise and fall alternately, after the manner of two Buckets in a Well; which was done with so much ease, that two Men, with less than half their Strength, could perform all the Labour required: and in their descent they were directed by Lines fastned to the under edge of the Bell, the which pass through Rings placed on both sides the Leathern *Hose* in each Barrel; so that sliding down by those Lines, they came readily to the Hand of a Man, who stood on the Stage on purpose to receive them, and to take up the ends of the *Hose* into the *Bell*. Through these Hoses, as soon as their ends came above the Surface of the Water in the

the Barrels, all the Air that was included in the upper Parts of them was blown with great force into the Bell, whilst the Water entred at the Bung-holes below, and fill'd them: and so soon as the Air of the one Barrel had been thus received; upon a signal given, That was drawn up, and at the same time the Other descended: and by an alternate Succession furnished Air so quick, and in so great Plenty, that I my self have been One of Five who have been together at the Bottom, in nine or ten Fathoms Water, for above an Hour and half at a time, without any sort of ill consequence: and I might have continued there as long as I pleased, for any thing that appeared to the contrary. Besides the whole Cavity of the Bell was kept entirely free from Water, so that I sat on a Bench, which was diametrically placed near the Bottom, wholly drest with all my Cloaths on. I only observed, that it was necessary to be let down gradually at first, as about 12 Foot at a time; and then to stop and drive out the Water that entred, by receiving three or four Barrels of fresh Air, before I descended further. But being arrived at the Depth designed, I then let out as much of the hot Air that had been Breathed, as each Barrel would replenish with Cool, by means of the Cock at the Top of the Bell; through whose Aperture, though very small, the Air would rush with so much violence, as to make the Surface of the Sea boyle, and to cover it with a white Foam, notwithstanding the great weight of Water over us.

Thus I found I could do any thing that was required to be done just under us; and that, by taking off the Stage, I could, for a space as wide as the Circuit of the Bell, lay the Bottom of the Sea so far Dry, as not to be over-shoes thereon. And by the Glass Window, so much Light was transmitted, that, when the Sea was clear, and especially when the Sun shone, I could see perfectly well to Write or Read, much more to fasten or lay hold on any thing

thing under us, that was to be taken up. And by the return of the Air-Barrels, I often sent up Orders, written with an Iron Pen on small Plates of Lead, directing how to move us from Place to Place as occasion required. At other times when the Water was troubled and thick, it would be dark as Night below ; but in such Case. I have been able to keep a Candle burning in the Bell as long as I pleas'd, notwithstanding the great expence of Air requisite to maintain Flame

This I take to be an Invention applicable to various Uses ; such as *Fishing for Pearl*, *Diving for Coral*, *Spunges and the like*, in far greater Depths than has hitherto been thought possible. Also for the fitting and plaining of the Foundations of Moles, Bridges, &c. upon Rocky Bottoms ; and for the cleaning and scrubbing of Ships Bottoms when foul, in calm Weather at Sea. But as I have no experience of these matters, I leave them to those that please to try. I shall only intimate, that by an additional Contrivance, I have found it not impracticable for a Diver to go out of our Engine, to a good distance from it, the Air being conveyed to him with a continued Stream by small flexible Pipes ; which Pipes may serve as a Clew to direct him back again, when he would return to the Bell. But of this perhaps more hereafter

VIII. *Observations on the Glands in the Human Spleen ; and on a Fracture in the upper part of the Thigh-bone. By J. Douglass, M.D. and R. S. S.*

THAT Anatomy, as well as Physick and Surgery, has received much improvement from a careful and true observation of what was found in the Dissection of morbid

morbid Bodies, will appear from the two following Instances, among many more that might be adduced for that purpose. For it is certain, that nothing has contributed so much towards forming a right Notion of the Nature of the several Diseases, and a true knowledge of the Structure of many Parts of the Human Body, as their appearance in a preternatural State.

My first Observation is of the Glands visible to the naked Eye, that appear dispersed thro' the Fibrous Substance of the Human Spleen. The Subject I found them in, was a Boy of about 4 or 5 Years Old, that died of a general *Atrophy*, or Consumption of all the Muscular Flethy Parts of the Body, occasioned without all doubt from the numerous Glandulous Swellings scattered up and down the whole Mesentery; which by compressing the Lymphatick Vessels, called in this place *Vasa lactea*, prevented the access and supply of the Chyle, so necessary for the continued nourishment and increase of the Parts. For without the constant Recruit of this whitish Balsamick Liquor, the Mass of Blood will in a short time be unfit to perform any of those good Offices, which a fresh accession of Chyle qualifies it for.

In a piece of this Spleen we might see, without the assistance of a Glass, several round whitish Bodies of a pretty hard Consistence, and abundance of small white and softer specks; but both of the same nature. These, to me at least, appear to be so many distinct Glands become visible; which in a Natural State are only to be seen by a fine Glass, as the curious *Malpighius* first observed. *Vid. his Treatise de Liene, Cap. V. De quibusdam corporibus per Lienem dispersis. Minime hæ glandule, says he, non æque facile sese produnt in quocunque animalium Liene: imo solâ Lienis laceratione innotescunt in Bove, Ove, &c. In Homine vero difficiliter emergunt: si tamen ex morbo universum glandularum genus targeat, manifestiores redduntur, quæta*  
*insparum*

*ipsarum magnitudine, ut in defuncta puella observavi : in quâ Lien globulis conspicuis racematim dispersis totus scatebat.*  
Which Case was the very same with mine.

The second Observation. We had still been in the Dark, about the nature of a Luxation of the Head of the Thigh-Bone, had we not carefully examined the Part in the dead Body. For by that sort of enquiry, the common mistake of Surgeons was detected, and what was esteemed and treated by them as a Luxation of the Head of the *Femur*, was discover'd to be nothing else but a Fracture of the same Bone, near its Neck; the globular Head being still retained close in its own Socket, called the *Acetabulum Coxendicis*.

Amongst all the Writers of Surgery and Anatomy, I know but three that were apprised of this mistake: the first was *Ambrose Paree*, the second Dr. *Ruyseh* at *Amsterdam*, and Mr. *Chefelden*, a Member of the *Royal Society*; whose Observations on this Subject I intend to communicate at another time, together with an account of the true Structure of this Joint; in which I will consider the depth of the Articulation; the wonderful strength of the Muscles that surround it; the many strong ligaments that bind the Head within the Socket; the smallness of the Neck of the Bone; its poreous and spongy Substance, which makes it much weaker than the rest; and last of all the disadvantageous oblique position of this Neck, which exposes it the more to outward accidents. From a review of such like Considerations, it will plainly appear that a Fracture can much more easily happen, than a Dislocation in that Part from an external Cause.

This *Os femoris* belonged to an old Woman turn'd of Fourscore, who only fell from her Chair whereon she was sitting, and thereby suffered this breach of continuiry in the substance of the Bone. She lived three Weeks after it; and tho' it never was reduc'd, yet she complain'd of

H h h h

very

very little or no pain, which may seem very extraordinary. It is observable that the Fracture is not only Oblique, near the Neck of the Bone; but that each *Trochanter*, i.e. the two processes near its *Cervix*, are likewise broke short off; and that they were both drawn up almost as high as the Head of the Bone it self by the strong contraction of the *Glutei* and other Muscles.

---

IX. *An Account of a Book.* DISSERTATIO de DE A S A L U T E, In qua illius Sym-bola, Tempia, Statuæ, Nummi, Inscriptio-nes exhibentur, illustrantur. Auctore Guil-helmo Musgrave G. F. è Coll. Exon. Oxonii: Typis Leon. Lichfield: Impensis Phil. Yeo, Bib-liopolæ Exon. Anno MDCCXVI.

THE Author of this Treatise, as the occasion of it, observes that the little God *Telephorus* had just cause to complain, that so much respect was paid to *Dea Febris*, and a Book lately publisht *de Dea Pedagra*, yet no such Honour was done his Mother *Υγίεια*, (who certainly was more to be esteemed, than all the Tribes of Diseases). Upon this Conceit, he took what Books he had in his reach, of the antient Latin and Greek, and having collected out of them, what he met with relating to this Goddess, put it together, as now it appears in Print.

It consists of VI Chapters: of which the first is Introductory, speaks of Health in general, has, in praise of it, that memorable Ode of *Ariphron* the *Sicyonian*, publisht by *Athenæus*, and translated by *Sennertus*; together with a Hymn, said to be composd by *Orpheus*, on the same Subject;

Subject; he ranks this Goddess among the *Dii Medioximi*, and gives an account of Her from the Mythologists.

Chap. II. de *Salutis Symbolo*, which he takes to be a *Serpent*, an *Omen* of good things, and a frequent Companion of the Gods; as appears from *Virgil*, *Valerius Flaccus*, *Statius*, and *Macrobius*. He mentions another *Symbolum Salutis*, used by *Antiochus Soter*, now to be seen in some of his Coins, and sometimes printed in *Phylick Books* in the following form.



The III. Chapter treats of the *Temples* erected to this Goddess; in which *Prayers* were offer'd up to Her, sometimes for the Health of private Persons, and often for the welfare of the Publick: of which many Instances are here produced. To the account of *Temples* is subjoyned the *Divination*, known by the name of *Salutis Augurium*, which is often mentioned by Roman Authors, as *Dion Cassius*, *Tully*, and *Tacitus*.

In the IV. Chapter, the *Statues* of this Goddess are consider'd. Some of these represent her and *Æsculapius* together, *tamquam Deus Συμβώμης*. *Pliny*, *Pausanias*, *Lucian*, *Plutarch* and *Monfaucon* afford instances of this kind.

*Coins* relating to this Goddess, come next in view, Chap. V. These either express her *Efigies*, or her *Worship* under some Symbol or other. Of the first order, one out of *Fulvius Ursinus* has the Head of the Goddess, with SALUS inscribed. Another like this, is in *Grævarinus*. Some, together with this Goddess have also her Father *Æsculapius*; as a *Coin* of *Trajan*; and in one of *Ærelins Antoninus*, struck in memory of the Remedies reveal'd to him in a Dream, which cured the Emperor of

a *Sputum Sanguinis* and *Vertigo*. As indeed most of these Coins were (in all likelihood) struck on some such occasion, viz. the Recovery of some great Person. A noble Expression of Gratitude, fit and worthy of imitation.

Of the second Order is the Coin of *Deffenus*, having an Altar with a Serpent, taken from *Ursinus*. Another of *Tiberius*, with an Altar and S A L. A U G. Another of *Nero* in which is a *Serpens Tortuosus*; with many others.

The *Gemme* of the Antients, according to *Leonardus Augustinus*, are of use to set forth the Sacrifices made of old to this Goddess. One of these *Gemme* represents *Æsculapius*, his Daughter *Hygieia* and Grand-Son *Telispheus* so call'd ἀπὸ τῆς τέλης φέρειν, à *Valetudine post morbum confirmata*. This God, being Young and Tender, had (I suppose, by the care of his Mother *Hygieia*) a *Bardocucullus*, or Cloket, to keep him from taking Cold. These three Gods are represented in one Figure, with the following Inscription under them, ERZETE ME, i. e. *Salvete me Jubete*, which *Augustinus* happily conjectures to have been a Form of Prayer offer'd up to them.

In the last Chapter come the Inscriptions, which are taken out of *Gruter* and *Reinesius*. They are chiefly to *Æsculapius* and *Hygieia*; but to confirm the Divinity of *Telispheus* the little God of the *Pergameni*, he is mentioned in one of their Inscriptions dug up at *Verona*.

The Author makes no manner of doubt, but there are many more Coins and Inscriptions relating to this Goddess to be found in other Books. But these being all, or most of such as came in his way, and enough to give a Specimen of the Devotion paid by the Antients to this Goddess, he has contented himself with this small Number; leaving it to others to make such Additions, as from greater Opportunities and Abilities, they shall think fit.



# PHILOSOPHICAL TRANSACTIONS.

---

For the Months of Octob. Novem. and Decem. 1716.

---

## The C O N T E N T S.

- I. *Observationes nonnullæ Planetarum Primariorum, ac speciatim Stellæ cujusdam fixæ à corpore Jovis interposito occultatæ ; a R. D. Jacobo Pound, R. S. Soc. nuper habitæ, & ab eodem cum Reg. Societate communicatæ.*
- II. *A Description of that curious Natural Machine, the Wood-Peckers Tongue, &c. By Richard Waller, Esq, late Secretary to the Royal Society.*
- III. *The Natural History and Description of the Phœnicopterus or Flamingo ; with two Views of the Head, and three of the Tongue, of that beautiful and uncommon Bird. By James Douglass, M. D. Reg. Soc. S. With an Advertisement : by the same.*
- IV. *An Index to the XXIXth Volume of these Transactions.*

- I. *Observationes nonnullæ Planetarum Primariorum, ac speciatim Stellæ cujusdam fixæ corporis Jovis interpositu occultatæ; a R. D. Jacobo Pound, R. S. Soc. nuper habitæ, & ab eodem cum Regia Societate communicatæ.*

**A**lsque Observationibus accurate institutis, irritò sane conamine veræ motuum Cœlestium Theoriæ Calculusque cælo conformis expeterentur. Quod autem tam diu latuerit Veritas Astronomica ex eo factum est, quod Veteres Artifices, & imprimis *Ptolemaus*, nulla omnino nobis tradiderint Observata, præter ea quibus ad stabiliendas Hypotheses Tabulasque suas Principiis usi sunt: Cum tamen multo magis ex re fuisset *Timocharidis*, *Aristilli*, *Hipparchi* suasque *Ptolemai* ipsius *τηρησεως* debitâ fide ad nos transmississe, & numerorum suorum à Cælo dissensus ingenuè annotasse (ad exemplum magni *Hippocratis*, cui minime pudori fuit sub curâ suâ mortuos æque ac sanitati restitutos Posteritati consignasse) potius quam vanâ quâdam gloriolæ specie, Sphalmata sua sibi ipsis perspecta tacuisse; celatis sc. Observationibus iis quibus Tabulas suas male respondentes experti sunt. Hoc autem ante *Tychonem Brahe* omnium pene gentium Astronomis commune vitium.

Ex quo autem à sagacissimo *Keplero* adinventâ est genuina motûs planetarii Theoria, ejusdemque etiam Geometrica veritas à *Newtono* magno nuper patefacta, nonnullos ingens incessit cupido calculum Astronomicum Cælo omnino consentaneum exhiberi posse; & in eum finem, præter Observatores Principum, Privati etiam plurimi apud nos observandis Sideribus inhiant: Horum autem nemini arte vel industriâ secundus Rever. *D. Jacobus Pound*, Reg. Soc. Socius, Observationes sequentes

sequentes à se nuper apud *Wansted* habitas, Tubisque longissimis & Micrometro quantum fieri potuit accuratè captas, cum publico communicandas obtulit.

Anno 1715. *Augusti* 21°. 8<sup>h</sup>. 25<sup>h</sup>; Temp. æq. *Mars* præcedebat, scil. Ascensione rectâ, Mediam frontis *Scorpii* (*Bayero* δ) 6'. 54" Borealior Fixâ 9'. 47".

*Sept.* 18°. 7<sup>h</sup>. 30'. *Mars* præcedebat *Claram* in pede *Serpentarii* (*Bayero* θ) 17'. 48". & eandem habuit Declinationem accuratè.

*Novemb.* 30. 18°. 8'. *Saturnus* præcedebat γ, sive secundam *Alæ Virginis* 23'. 19" & erat Fixâ Australior 25'. 3". *Decembris* autem 4<sup>o</sup> 17<sup>h</sup>. 25'. præcedebat eam 10'. 50" & Australior erat 29'. 00".

Anno autem 1716. *Feb.* 22°. 7<sup>h</sup>. 23' T. æq. *Mars* præcedebat ζ *Piscium*, sive Sequentem trium clariorum in *Lino Aust. Piscium* 3'. 35". eâdemque Australior erat 1'. 23", quam proinde obregere debuit ante bihorium, forsan corporaliter.

*Junii* 22°. 8<sup>h</sup>. 52'. T. æq. *Venus* sequebatur *Cor Leonis* 34'. 50", & fixâ Australior erat 7'. 23".

*Aug.* 14°. 15<sup>h</sup>. 00'. *Jupiter* præcedebat *Propoda* uno tantum minuto, cum Declinatione Bor. minore 14'. 26".

*Aug.* 19°. 13<sup>h</sup>. 2' *Jupiter* præcedebat fixam *Telescopicam*, quæ vocetur *b*, 50', 08" eandem habens Declinationem accuratè.

*Aug.* 24°. 12<sup>h</sup>. 19' *Jupiter* Micrometro distabat a prædictâ *b*, 5'. 54", simulque ab aliâ Fixâ clariore *a* 7'. 17". Distantia fixarum 12'. 31". Tunc minor *Jovis* diameter 0'. 38"

*Sept.* 12°. 17<sup>h</sup>. 00' *Venus* recens a Statione secunda sequebatur *Telescopicam* 17'. 40", eâque Australior erat 5'. 30". Hæc autem Fixa tunc occupavit α 27°. 44<sup>h</sup> cum Lat. Aust. 5°. 39.

*Octob.* 15°. 17<sup>h</sup>. 12<sup>h</sup> *Venus* distabat Microm. a Fixâ π in *Crure Leonis* 27'. 55".

*Novemb.*

*Novemb. 20°. 6h. 18<sup>h</sup>. Jupiter regressus est ad stellas a & b, ad quas observatus est Aug. 24°. & distabat à b 6'. 21", ab a vero 11'. 36".*

*Novemb. 21. 7<sup>h</sup>. 38', Jupiter distabat à b 9'. 19", & ab a 3'. 48". Fixæ inter se 12'. 30". Jovis diameter minor sive Axis 0'. 44". Deinde hora 18<sup>h</sup>. 50'. visa est stella a limbo Jovis quasi adhærere, eratque quasi  $\frac{1}{2}$  semidiametri vel 0'. 15". centro Jovis Borealis. Juxta has autem observationes constat medium Occultationis Fixæ, interposito Jovis corpore, contigisse Nov. 21°. 19<sup>h</sup>. 55'. vel proximè. Deinde*

*Nov. 30. 5<sup>h</sup>. 41'  $\pi$ . preced. Propæda 12'. 36" Australior 7'. 26"*

*Dec. 4. 6. 0  $\pi$ . Sequeb. eam 22. 49 ———— 7. 47*

*Dec. 5. 6. 0 Repet. ———— 31. 35 ———— 7. 50*

*Dec. 6. 6. 0 Repet. ———— 40. 30 ———— 7. 52*

*Dec. 7. 6. 0 Iterum ———— 49. 15 ———— 7. 54*

*Ex his ultimis Observationibus liquet Jovem & Propæda eandem habuisse Longitudinem Dec. 1°. 15<sup>h</sup>. 29', quo tempore Jupiter Australior erat stella 7' 40'. Ex iisdem etiam constabit Jovem in opposito Solis fuisse, quoad Longitudinem. Dec. 6°. 12<sup>h</sup> 46'.*

*N. B. Stellæ illas Telescopicas a & b vocatas, haberi in Catalogo Fixarum Britannico D. Flamsteedii, ubi ipsi a Locus datur, ad annum Scil. 1690 ineuntem,  $\pi$  27°. 54'. 29" cum Lat. Aust. 0 21'. 55"; alteri vero b  $\pi$  28°. 5'. 24" cum Lat. Aust. 28'. 5". Neque aliam novimus Fixam à corpore Jovis occultatam & ab invento Telescopio observatam, præter jam dictam Stellam a; ad quam olim arctissime applicabatur Jupiter, ante annos 83. Decembris nono St. nov. Anni 1633. Vesp. cum Gassendus Diniæ vidit Jovem huic Fixæ conjunctum, nec nisi quinque semidiametris corporis sui superiorem. Unde calculo debitè inito, constabit Nodos hujus Planetæ Planumque Orbis ejus, situm in Sphæra Fixarum servare immobilem, vel saltem lentissimo motu cieri. Vide Gassendi Observ. Tom IV. p. 162.*

II. *A Description of that curious Natural Machine, the Wood-Peckers Tongue, &c. By Richard Waller Esq; late Secretary to the Royal Society.*

THE *Picus Martius* or Wood-Pecker has several Particularities in the Structure and Mechanism of its whole Body, which may deserve a nice and accurate Observation and Description: all which are wisely contrived and adapted, either for catching the Food and Sustenance of the Individual, or continuing the Species.

That this Bird makes a round Hole even in sound and hard Trees, such as the Oak, Horn-beame, Beech and the like, is commonly observed; and that within these Holes, the Hollow being enlarged, the Nest is made, the Eggs laid and Hatch'd; and the young Brood fed, as by other Birds.

For this purpose, that he may be enabled to perform such hard work, the Muscles of his Neck, Breast, and Thighs. are exceeding strong in proportion to the bigness of the Bird: he has also a very firm strong sharp Bill, his Legs are strengthened with very strong Tendons; and his Toes, which are two before and two behind, (as it is in some other Birds) are provided with sharp strong hooked Claws or Talons: Besides this, his Tail consists of ten very stiff large and strong Quills, firmly set into a robust strong *Uropygium* or Rump; so that when he has fastened his Claws and Feet into the Clefts and Inequalities of the Bark of the Tree, he claps his strong Tail-Feathers against the Body of the Tree; and so stands with his Head erect, to give the strokes with his Bill with the greater Force.

That he is of the Insectivorous kind is certain, and lives not only upon Insects catcht creeping on the outside of Trees, but also on such as are under the Bark between the Bark and Wood, as likewise on those in rotten Wood; and as I am very confident on Worms and other Insects in the Ground: for I have frequently observed the Roots of their Bills very dirty, as it is in *Crows* and *Rooks*, &c. Whence I suppose he strikes his long sharp Bill into the soft Earth to take the Worms out of it. I have also found their Crows full of small Ants.

But the Contrivance and Mechanism of the Tongue in this Bird being the most Remarkable, I shall presume to lay before this Illustrious Society some few Remarks of this curious Contrivance of Nature, with some Figures I have drawn by the Parts themselves, in order to explain the whole.

This Bird is known to throw out a long, slender, round Tongue, to a considerable distance beyond the End of his Bill; and to draw it in again very quick into his Mouth or Bill, with the caught Insect spitted on the Tip of it.

The *Chameleon* indeed darts out its Tongue to a considerable length; and having intangled the Fly in the glutinous Matter at the End of it, draws it into its Mouth, together with the Prey; but the Mechanism in that Animal is wholly different from that of the present Subject: as may be seen by the Account the Gentlemen of the *Academy Royal* give thereof, in their *Memoirs* for a History of *Animals*.

The Protrusion therefore of the Tongue to the length even of three or four Inches in this Bird, being very extraordinary and the Mechanism of the several Parts for that end no less Curious; several learned and diligent Enquirers have attempted to explain it; but I am of  
opinion

opinion they have been, in some Particulars at least, mistaken. I shall mention some of these.

The learned and curious Enquirer into Nature, *Monf. Perault*, describes it after this manner \*.

This long Tongue he throws out by the means of two small bony Cartilages, about seven Inches long, and of the thickness each of a middling Pin, which are perfectly Smooth and Slippery. These two Cartilages are united at the End, and being in this place covered with Flesh make the fore-part of the Tongue. The rest of these Cartilages are separated from each other, and pass turning round under the Ears; and then rising up behind the Head, where they meet again, they pass over the Top of the Head, and so extend themselves to the Root of the Beak. These Cartilages which make the hinder part of the Tongue, are also inclosed in a Channel Flesh on the out-side, and whose inside is covered with a very smooth slippery Membrane.

Now these Flethy Channels, which encompass and keep in these Cartilages, are the Muscles by which the Tongue is moved: for having their origine at the *Larynx*, and their insertion at the extremities of the Cartilages, it comes to pass, that when those Muscles of the two Flethy Channels, which make the hinder part of the Tongue are shortned, they force the fore-part of the Tongue out of the Beak, by drawing the posterior or farthest end nearer to the *Larynx*: and on the contrary, when the Flethy Channel which makes the anterior Part acts, it draws the fore-part of the Tongue into the Bill towards the *Larynx*.

This Mechanism of making a hard part, such as the bony Cartilages are, to come out and return into another,

\* *Essays de Physique*, Tom. 5. Part 2. p. 148.

such as the Canals are, by the means of Cords drawing them, which are the Muscles, is made use of in Coaches to pull up the Glasses of the Doors; for the String, being fasten'd to the lower part of the Glass-Frame, makes it rise when drawn, which resembles that action of the Muscles by which this Tongue is moved.

Of these Cartilages and other Parts, and of the Head of the Bird, Mr. *Perault* gives the Figures.

Either the Wood-peckers in *France* are different from ours in *England*; or this Figure of the Head is very ill designed; it being much too broad and large, and the Beak too short. Besides he makes the two Cartilages to come to the Root of the Beak separately, one on one side, the other on the other side of it; whereas in all the Wood-peckers Heads I have met with, the two Cartilages joyn close together about the Top of the Head, and thence proceed joyned, tho' not fastned to one another, a little slanting towards the right Nose-hole, where they end together.

Besides upon viewing and examining several Subjects, I could not find them agree in divers particulars with his Account and Explication. For the Muscles which are fastened to the end of the Cartilages at the Root of the upper Beak, are not inserted at the *Larynx*, but pass on and are fastened to the lower Bill. This pair I take to be the Muscles chiefly concerned in forcing the Tongue out of the Bill. There is another pair of Muscles, which, being fastened to the place where the two bony Cartilages are articulated with one single Bone in the fore-part of the Tongue; (as will be shewn in the 4th Figure) is, as I apprehend, the chief pair concerned in the drawing the Tongue with its Prey into the Mouth. These proceeding from that articulation of the Cartilages as far as the *Larynx*, (each of them sending a Branch to the *Cartilago Scutiformis*) from thence go on along with

2

the



the Neck, (tho' not fastned to it) till they come within the Cavity of the *Thorax*, where they are inserted under the *Clavicula* or *Merry-thought-bone*, as 'tis called. This pair is represented by *k. k.* in the second Figure; and by *q. q.* in the First.

There is likewise a very slender white Thread, (whether Tendon or Nerve, I am uncertain) which accompanies this Muscle its whole length; and which drawn gently, (for fear of breaking) pulls in with it the end of the Tongue. As there is such another all along the *Vagina* to the End at *c.*

*Volker Coiterus*, as he is mentioned by *Gerard Blasius*, in his *Anatome Animalium*, *Cap. 24. p. 64.* treating of the Tongue of this Bird, makes it to be made of three slender Bones, round, and as he says bound together; (*invicem colligatis*) which is a Mistake; for tho' reckoning the two bony Cartilages for *Officula*, yet the third is not bound up with them, but articulated to the End of them. The same Person says the Tongue may be thrust out to the length of an Inch and a half, whereas when drawn in, it is scarce half an Inch long; when in reality it may be thrown out near four Inches; and I believe cannot be drawn in, so as to be less than an Inch and quarter, *viz.* to that place where the two Cartilages are articulated with the single Bone. Besides he makes the use of the long flat Muscle running over the Top of the Head, to be (if I rightly apprehend his meaning) to draw the Tongue to the upper Jaw, whereas their use is for thrusting the Tongue out of the Birds Mouth.

But this Person having given no Figures, has rendred what he says less intelligible; tho' indeed he mentions two pair of Muscles, as there are so many chiefly concerned, yet there are at least two other pair, that assist the Performance.

Where

Wherefore I shall leave him, and proceed to the Account given by *Alphonſus Borellus* in his Treatiſe *de Motu Animalium*, part. 2. pag. 24. which is in ſeveral Reſpects likewise unſatisfactory, and the Figure given by him to explain it very defective and ill deſigned.

He makes the pair of Muſcles concerned in thruſting the Tongue out, to be faſtened indeed as they are to the lower Beak towards the Point; but then he makes their Inſertion at their other End to be at the extremities of the two *Oſſa Hyoidea*; whereas they really reach to the very end of the long Cartilages that go round the Head: Theſe by another Miſtake, he makes to be the Rerractors of the Tongue, and joins another pair as Aſſiſtants in the ſame Action, which he makes to be twiſted ſpirally about the *Trachia*. None of all which agree with the Subjects I have met with, as will be ſeen by the deſcriptions of my Figures.

In the Hiſtory of the *Academie Royale des Sciences*, publiſh'd in Latin by Monſ. du Hamel, 1698. Lib. 4. Cap. 5. There is another Deſcription of this admirable Contrivance of Nature, by Monſ. Mery, read at a Meeting of the *Academie*, November 16, 1695.

In this he differs from both *Perault* and *Borelli*, taking the Horny End and Bone to which it is joined, to be only the Tongue properly ſo called, and that the next two Bones answer the *Hyoïdes* with the long Cartilages annexed to them. But even in this he ſeems to me not to be ſo clear; confounding, as I apprehend, the two Bones with the Cartilages. He deſcribes the *Vagina*, in which the Bones and part of the Cartilages are encompassed, and which is faſtened to the Horny end. and is protruded and drawn back with the Tongue: he takes notice of the little ſharp Points or Prickles on the Horny Part being moveable, and with their Points bending towards the Throat; but I apprehend it is a Miſtake to make the

Mucous matter Glutinous which is furnished by the two *Pyramidal Glands*; for I take the use of that *Mucus* to be chiefly, if not only, to lubricate the Passage in the *Vagina*, for the more easy slipping of the Cartilages therein.

He describes the Muscles for exerting the Tongue, and extends them from their Insertion at the lower Beak, to the End of the springy *Ligaments*, as he terms what I call *Cartilages*; to which he adds another small Ligament capable of Extension, at the End of the other two next the Nose, which when the Tongue is thrust out is relaxt and stretch'd. He also describes the pair of Muscles fastned to the Root of the Tongue and *Os Hyoides*, serving to draw the Tongue into the Mouth: these he makes to be wound round about the *Aspera Arteria* once or twice, in which I think there is some Mistake; being of opinion the Mechanism for this Action of drawing in of the Tongue, is different from what is here described, as in the Explication of the Figures I shall endeavour to shew. But not to insist on all the Particularities mentioned in this Description, which, for want of more Figures to explain the several Parts in so curiously contrived an Organ, is not so clear as might be desired (there being but One, and that a wooden Cut of the Head, Tongue, Bones, Muscles, &c.) I shall now proceed to the Explication of the several Draughts I made, with what exactness and care I could, in 8 or 10 several Subjects.

#### FIGURE the First.

Represents the Head with part of the Neck of this Bird, the Skin being taken off, in which,

A. The Skull, having two shallow Grouves or Channels, or rather one broad one with a small Rising in the midst, on the *Sinciput* or Back-part, from each side of the Neck to the Top of the Head, where they unite into

one

one, which passes slanting towards the right Side, and ends at the Hole for the Nostril on that side at *c*.

*b*. Is the Hole or passage for Hearing.

*d*. A large white Gland, containing a glutinous Liquor, almost like Cream as to Colour and Consistence, which empties it self into the Mouth; I suppose to lubricate the Cartilages.

*e*. The Eye, which has a Bony Ring, encompassing the *Iris*.

*f*. Part of the Tongue, which in this Figure is represented as almost all drawn into the Mouth, of which more when I come to describe the Cartilages, &c. In the 2d Fig.

*g*. Part of the Neck, which is large and furnished with very strong Muscles.

*h*. The *Oesophagus*, opening very wide at the *Fauces*, and wholly Musculous.

*i. i. i.* A long, but thin and flat Muscle in respect of its breadth, which is about  $\frac{1}{8}$  of an Inch, reaching from the end of the Cartilage at *c*, to the under Bill or Beak at *k*, to the inside of which it is very firmly fastened; as is such another on the other side.

*k*. The under Bill very strong and sharp pointed, articulated with the Skull a little behind the Ear-hole *b*.

*l. l. l.* The Cartilage on one side, the other being exactly the same. This Cartilage is Round, very Smooth, Even and Slippery, about the size of a pretty large Pin; and reaches, when the Tongue is drawn in and the Muscle *i. i. i.* relaxed, from the Root of the upper Beak at *c*, to the Root of the Tongue properly so called, or to the Bones of the Tongue where they are articulated, being bent like a Hoop as in the Figure, slipping very freely in a Sheath or Membranous *ductus* fastned on the outward or convex Edge of the flat Muscle *i. i. i.* which Muscle accompanies it from its end at *c*, almost to the end

end of the Canal or Sheath, which opens at a Hole a little before the *Larynx*; (as will be shewn in the third Figure) and thence the Muscle proceeds to its Insertion into the lower Beak at *k*. From the concave Edge of this Muscle, there is a thin and transparent but very strong Membrane, strained like a Drum-head to the Scull at *m*, where it is very strongly fastned; this Membrane is furnished with Capillary Veins and Arteries, and doubtless is Nervous. *n. n.* represents this Membrane. This Cartilage, when the Tongue is exerted, parts about half an Inch from the Root of the Beak at *c*.

*o. o.* A pretty large Vein and Artery.

*p. p.* A Muscle reaching from one Jaw to the other, under the Throat, serving as a Bandage to keep in the Cartilages, and the Root and *os Hyoides* of the Tongue, as I may call it, from starting out at that Part where are the articulations of the Cartilages with the Bones, when by the Muscles, inserted into the Sheath at or near *p* and thence passing to the end of the Tongue, it is drawn into the Mouth.

*q. q.* One of the last mentioned Muscles, which is round, of the size in the Figure, and fastned to the Breast of the Bird, cut off at *r*.

*s.* The *Aspera Arteria* consisting of perfect Rings.

*t. t.* A Muscle accompanying the *Aspera Arteria*.

#### FIGURE the Second.

*A. A.* The under part of the lower Bill.

*B. b.* The Tongue.

*b.* The Place where the two Cartilages and two Bones represented by *f. f.* in Fig. 4. are brought into and inclosed in one Tube or Membranous Sheath.

*C. C.* Two Glands displaced in this Figure.

*e. e.* Two Muscles attending these Glands, and fastned near the end of the Bill.

L I I I

*D. D.* The

*d. d.* The two Bony Cartilages, bent, and passing on each side of the Neck, but united at *b*.

*eee, eee.* The pair of Muscles, one attending each Cartilage from the End of it at the upper Beak, and firmly adhering to the *Vagina*, in which it slips, till about *ff*.

*f. f.* The place where these Muscles leave the *Vagina*, and pass on to the inside of the Bill, where they are inserted. Their Action is to thrust the Tongue forward, or out of the Mouth.

*g. g.* A pair of Muscles fastned a little below the *Larynx*, to the Musculous part of the *Aspera Arteria*, at *i*; the other end of them going up to the place *b* at the Root of the Tongue, whence they go on incompassed by the *Vagina* to the articulation of the Cartilages with the two Bones. I take their Action to be to draw the end of the Tongue towards the *Larynx*.

*k. k.* Two Muscles fastned at one end within the *Thorax*, under the Merry-thought or *Clavicula*; and at the other Ends to the articulation of the Cartilages with the two Bones of the Tongue, marked *f. f.* in Fig. 4. These have the forementioned Nerves accompanying them. I take these to be chiefly concerned in drawing in the Tongue; each of these sends a Branch to the Gristle at the Top of the *Aspera Arteria* at *n*.

*l. l. l. l.* Two Muscles running along and fastned to the Sides of the *Aspera Arteria*, from the *Thorax* to the place where they are united, where each of them sends a Branch; which binding over the Bones and Cartilages goes on to the *Fauces*, where they are inserted.

*m.* Part of the *Gula*.

*n.* A Cartilage at the Top of the *Aspera Arteria*.

*o. o.* The *Aspera Arteria*.

*p.* The Neck bending like an *S*. The Wind-Pipe  
and

and *Gula* in this Bird pass always on the right side of the Neck.

### FIGURE the Third.

*A. A.* The two long flat Muscles represented by *i. i.* in the first Figure. These join close to one another at the Top of the Head, and so pass on together to the end of the Cartilages; to the end of which, as I take it, they are fastned: from whence a slender weak kind of Ligament reaches to, and is inserted at, the right Nose-hole, at the Root of the upper Beak. This Ligament is relaxt when the Tongue is thrust out.

*b. b.* The Cartilages running in their *Vagina* on the out side of the said Muscles.

*c.* The *Larynx* or passage to the *Aspera Arteria*. I observed no *Epiglottis*.

*d d.* Two Articulations or Joints in the under Beak or Bill.

*e.* The Hole or Passage, whereby the Tongue in its *Vagina* comes out and is drawn in again.

*f.* What I call the Tongue, in the inside of which the two Cartilages are brought together, till they are both articulated to one single Bone, at the end of which is the Horny barbed Tip.

*g.* One of the Pyramidal Glands.

*h.* The lower Bill.

### FIGURE the Fourth.

*A.* That part which I think may most properly be called the Tongue; a small Bone running thro' it: This, as far as *c*, is Flat and Thin at the Sides. It is cut away at *d*, to shew the Bones within it.

*b.* The Horny Tip of the Tongue, about a quarter of an Inch long, strong and sharp, furnished with four or five Barbs on each side; (not with an infinite Number as

*Coiterus* says) These Barbs are sharp and moveable, like the small Teeth at the Root of the Tongue, and beginning of the *Gula*, in the *Pike* and *Jack-Fishes*, in that of Eagles and the like; so as to let the Prey slip easily on, but not so easily get off again..

*c.* The End of the Bone of the Tongue where the two bony Cartilages are articulated.

*d.* The place where the upper part of the Tongue is cut away to shew the Bone.

*e.* Several small Tendons, or rather, as I take them to be, Nerves running thro' the Tongue. Of these some go to the End of the Cartilages, others accompany the Muscles to the Neck.

*f. f.* Two Bones or Cartilages, which in the Bird, are united by a thin Membrane as far as the next joynt, so as to open asunder to some distance, but not to separate quite. These two Bones seem to answer to the *oss. Hyoidea* in other Creatures. At the Place marked *g. g.* the Muscle that draws the Tongue into the Mouth is fastened, or rather leaves the Tongue at that place; it having its Insertion near to the End of it: This Muscle is represented by *q. q.* in the first Figure.

*b. b.* The two bony and springy Cartilages running on each side of the Neck; which being joyned close together on the Top of the Head, pass so joyned to the Nostril, or Nose-Hole on the right Side.

From the Consideration and comparing of these four Figures, the true Mechanism and Motion of the Tongue, seems to be in short thus: The two long Muscles inserted near the End of this lower Beak, and reaching to the End of the Cartilages, being contracted, the round Hoop of the Cartilages is drawn up, from each side of the Neck, close to the Pyramidal Glands; and at the same time the Muscles that draw the Tongue into the the Mouth being relaxed, and the Articulations at *c*

and



and *g. g.* in the 4th Figure, brought near to a straight Line, the Tongue is thrown out to the length of 4 or 5 Inches.

But when those long Muscles are relaxed, the pair of Muscles represented by *k. k.* in the second Figure, being contracted, draw the Articulations *g. g.* where they are fastned, down into the Throat or wide loose Skin of the Neck; and at the same time the Cartilages opening into a wide Hoop, the whole Tongue is drawn into the Mouth.

### FIGURE the Fifth.

- A.* The Skull.
- b.* The shallow *Crena* or Groove, for the Cartilages.
- c.* The Place of their Ending at the right Nose-Hole.
- d.* The Orbite of the Eye.
- e.* The Hole for the Optic Nerve.
- f.* A Hole or passage thro' from one Orbite to the other.
- g.* A Bone covering the Hole to the Ear.
- h.* The lower Jaw and Bill.
- i.* A Ridge or *Processus* in the Skull, beginning at the Root of the upper Bill, and keeping the two Ends of the bony Cartilages in their place on the right Side.
- k.* The *Os Jugale*.
- l.* The upper Bill.

### FIGURE the Sixth

Represents the right Leg and Foot, in which there are two *Digiti* before, and two behind. The strength, Largeness, and Sharpness of the hooked Claws or Talons are remarkable.

FIGURE

## FIGURE the Seventh.

A. The *Oesophagus*.

B. The *Ingluvies* or Crop, partly Musculous, and lined with a Glandulous Coat. This I found quite filled with small black Pismires; as also

C. The *Ventriculus* or Gizzard, which joyned close to the *Ingluvies*.

d. d. d. The Intestines nearly of the same bigness for the whole Length.

e. The beginning of the *Rectum*.

f. The *Pancreas*.

## FIGURE the Eighth.

One of the middle pair of Feathers of the Tail, in which the great Strength of the Quill for so small a Feather, and its bifurcate End, are very remarkable.

## FIGURE the Ninth.

The Roof of the Mouth, where'tis observable, that the *Rima* or Passage for the Air to the Nostrils, is beset on each side with a Row of 10 or 12 little sharp Teeth, with their Points standing inwards, towards the *Gula*. These take the Prey from the end of the Tongue whose Barbs or Prickles are moveable, and are to keep it from going out of the Beak again with the Tongue, and from hence it is conveyed to the Swallow.

Fig. 1.

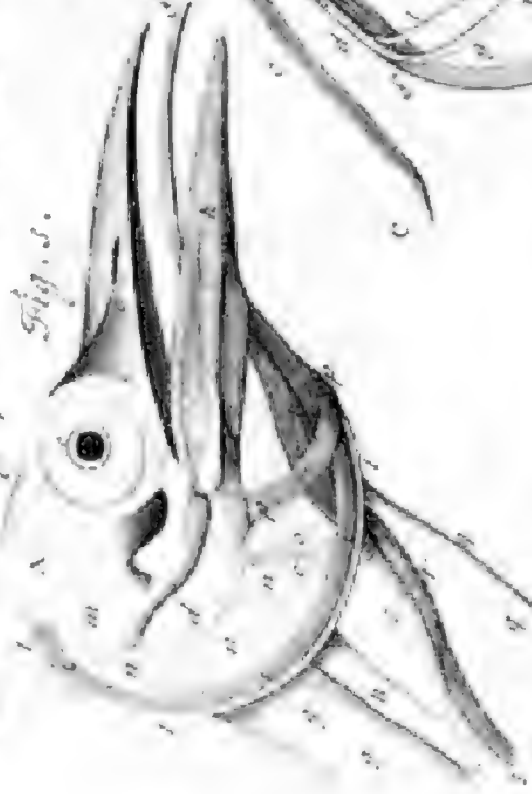


Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.

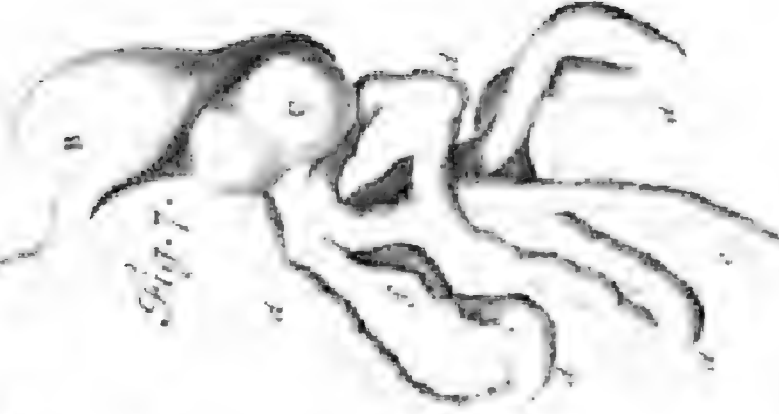


Fig. 8.



Fig. 9.



III. *The Natural History and Description of the Phœnicopterus or Flamingo ; with two Views of the Head, and three of the Tongue, of that beautiful and uncommon Bird.* By James Douglass, M. D. Reg. Soc. S.

# N O M E N.

**I**T was the famous Comical Poet *Aristophanes*, that first makes mention of this Bird by the Name of Φοινικόπτερος (a), and not long after it is called ὄρνις Φοινίς (b) by *Philostratus* in his *Life of Apollonius Tyaneus*. *Apicius*, *Plinius*, *Suetonius*, *Juvenal*, and other Latin Writers, retain the Greek Word, and call it *Phœnicopterus*. *Bellonius* (c) says, that in French it is named *le Flement* or *Flambant*. *Scaliger* affirms, that in *Provence* they call it *Flammant* : And (d) *Gesner* says it may be called *Avis Rubra* per excellentiam. (e) *Aldrovandus* writes, that in *Sardinia* it goes by the Name of *Fiamingo* ; and *de Laet* tells us, the *Spaniards* in the *West Indies* call it *Flamenco*. *Dr. Charlton* and *Dr. Grew* convert the Greek Appellation into English, naming it the *Phœnicopter* : And *Sir Hans Sloane*, in his *Catalogue of Jamaica Birds* annexed to *Mr. Ray's Synopsis Avium*, styles it the *Flamingo*. (f) *Du Tertre* calls it *le Flamand*, which differs but little from the Name given it by *Bellonius* : And

(a) *Aristoph. Aves. Sc. 4.* (b) *Philost. Lib. 8. Pag. 387. Edit. Paris. 1605. fol.* (c) *Bellon. Histoire des Oyseaux, Lib. 8. Cap. 8.* (d) *Gesner Hist. Anim. Lib. 3.* (e) *Aldrov. Ornithol. Tom. III. Lib. 20. Cap. 4.* (f) *Hist. des Isles, &c. p. 300.*

to mention no more. (g) *Du Hamel* says 'tis commonly call'd *Becharu* in *France*.

### *Etymologia.*

All these differing Names may be easily accounted for, from the Colour most prædominant in its Wings. Thus *Martial* (Epigram 58. Lib. III.) says of this Bird:

*Nomenque debet quæ rubentibus pennis.*

And again (Epigr. 71. Lib. XIII.) he makes it give the true Derivation of its own Name;

*Dat mihi penna rubens nomen.*

The Greek Name is compounded of two, viz. *φοινίκεος*, *puniceus*, *ruber*, and *πτερόν*, *Ala*, a Wing, *quod sit rubentibus Alis*; which thing in different Words is express'd as follows, by the several Authors I have consulted. *Bellonius* says 'tis called in French *Flambant*, not only from the Date-Colour of its Wings, à *Dactylorum colore*, i. e. a Scarlet or light red, like the Fruit of the Palm or Date-Tree called in Greek *φοινίξ*; but also from the Lustre of the Colour resembling Flame: or as *Aldrovandus* has it, *quod velut ignis instar ejus rubedo emicet*. The Words of *Gesner* are, *Ego Gallicum nomen à rubro & flammeo rostri, crurum, pennarumque in aliquibus partibus colore inditum esse conjecerim: aut forte quoniam ex Flandria hyeme ad Narbonensis Provincia maritima volat; nam Flandrum Galli Flammant appellant: vel à corporis proceritate, quales solent esse Flandri*. *Mr. Willoughby* (h) says the French name it thus rather from the flammeous Colour of the Wings and Feet, than that it comes in the Winter Time

---

(g) *Hist. de l'Acad. Royale*, p. 213. (h) *Ornithologia*, Lib. III. S. 8. 2. C. p. 1.

from *Flanders*. For he believes there was scarce ever seen in *Flanders* a Bird of that kind; so far are they from being common there, and flying from thence into other Countries. (k) Dr. *Grew* believes it named in Greek from the Scarlet Colour of its Wings; and *Flamment* in French for the same Reason. *Du Hamel* explains its Name *Becharu* by *Aratri-rostrum*, (*quasi Bec-Charru*) *quoniam rostrum ejus aratri instar inflectitur*.

#### Genus.

All Authors, from *Aristophanes* down to *Aldrovandus*, have accounted the *Phaenicopterus* a Bird of the *Palmipede* or web-footed kind; and tho' this last named Author will not allow it to be so, yet he is forced to own that it is not a true *Fissipede* or digitated Fowl; *nam & membrana digitos sepientis quoddam habet rudimentum*, are his own Words. Dr. *Charlton* only, among all the later Natural Historians, has approved of his Division, and accordingly ranked the *Phaenicopter* in the Class of *Aquatick Fissipedes*. But that it is a Water-Fowl all agree; *Aristophanes* calls it λιμναῖος, i. e. *palustris*; and *Aldrovandus* says of it, *Avis est aquas amans*: not to mention others.

#### Differentiæ.

I find Authors are silent as to the different Sorts of this Bird, only *Aldrovandus* gives us two Figures thereof that are not alike.

#### Locus Natalis.

This Bird is found in three of the Principal Parts of the World, that is, in *Africa*, *America* and *Europe*. *Heliodorus* (*Æthiop. Lib. 6.*) calls it Νεχδων ποταμόπτερον, a Bird of the Nile; and the old *Scholiast* upon *Juvenal* (*Sat. xi. ver. 139.*) affirms, that *abundans est in Africa*; and *Du Hamel's* Words are, *Inter animantes*

*quæ sua mole commendantur, Avis illa ex Ægypto allata est, quam Veteres ob plumas in Alis rubeas Phœnicopterum dixerunt.* John de Laet writes, that there is an Abundance of them in the Island of *Cuba*, as also at the Isle called *Rocca*, lying on the Coast of the Province of *Venezuela* in *South America*; and *Rochfort* says the same thing of the Island of *St. Domingo*.

(l) *Dampier* saw some few of them at *Sal*, one of the *Cape Verde* Islands: He hath likewise seen some of them at *Rio la Hacha*; also at an Island near the Main of *America* right against *Querisao*, call'd by the Privateers *Flamingo-Key*, from the Multitude of these Fowls that breed there; and he never saw of their Nests and Young but there only.

Tho' these winged Creatures live for the most part in those hot Countries, yet they sometimes visit us here in *Europe*, and so may be accounted amongst the Migratory Kind, or Birds of Passage, which is confirmed by the Testimonies of several Authors: For,

*Bellonius* told us long ago, *migrant ultra mare*, and are often taken in *Italy*, and oftner in *Spain*.

(m) *Gassendus* says they are frequently caught in the fenny Grounds and Marshes about *Arles* in *Provence*, upon the *Rhone*.

*Gesnerus*. *Quidam mihi retulit avem hanc non procul à Monte-Pessulano capi.* He says in another Place, that they swim in Flocks not far from the Shore in *Mediterraneo Mari Gallico*.

*Willoughby* writes, that in hard Weather in the Winter Time, it comes over to the Coast of *Provence* (and is often taken about *Martiquez*, a Sea-Port Town in that Country) and in *Languedoc*, and is frequently found about *Montpelier*: But whence it comes and where it is bred,

---

(l) *Damp. New Voyage round the World, p. 67.* - (m) *Gass. Vita Peiresc. Lib. II. in fine.*

to me, says he, is unknown. *N.B.* This Passage is not in the Latin Edition of his Works, but added to the English which was published two Years after the first. However, he says positively, that they don't come from *Flanders*, where they are so far from being common, as some alledge, that there never was one seen in that Country.

(n) Dr. *Charleton* informs his Reader that he was presented with the Skin of one of these Birds, well stuffed and dried, by a Gentleman at his Return from the University of *Montpelier*, near which Place it had been taken. *Hujus exuvias ritè conditas insertasque mihi dono dedit præ-nobilis Juvenis D. Thomas Crew Eq. Aurat.*

(o) Dr. *Lister* says, *Frequens est Plænicopterus in paludibus maritimis ad mare Mediterraneum Provincia & Languedocia.*

Whether this Bird were known to *Aristotle* is a Question: for all our Writers of Natural History agree, that the *Plænicopterus* is no where mentioned by Name by the Philosopher; yet they can hardly believe that he was ignorant of a Bird so clearly described by his Contemporary *Aristophanes*. *Mirum est*, says *Gesner*, *hujus tam pulchra & eximia Avis nomen ab Aristotele taceri, cum Aristophanes, qui vixit eadem atate, meminert.* Sed *Græcis etiam raram esse hanc avem puto.*

*Bellonius* thinks that *Aristotle* described this Bird under the Name of *Glottis* or *Lingulaca*, as *Theodorus Gaza* translates it. *Aldrovandus* is of the same Opinion, but *Gesner* and *Scaliger* are not; for the first says, *Ego verò iis quas Gallinulas aquaticas nostri vocant avibus Glottidem ad-numero, quæ omnes fissipedes sunt*: And the latter in his Commentary upon this Passage says, *Glottis autem quæ sit nondum mihi constat. Ridiculum quod quidam de Phœnicoptero ausus est pronuntiare.*

(n) *Charlton de Differentiis & Num. Animalium.* (o) *Lister Annot. in Apicium Galium, Lib. VI. cap. 7.*



*Victus Ratio, Nidificatio, Volatus, &c.*

*Gesner* says, *circa lacus & paludes victitat*, and that it feeds on Perwinkles and Fish: And by *Dampier's* Account we learn, that they delight to keep together in Flocks, and feed in Mud and Ponds, or in such Places where there is not much Water; that they are very shy, and therefore it is hard to shoot them; that they build their Nests in shallow Ponds, where there is much Mud, which they scrape together, making little Hillocks, like small Islands, appearing out of the Water, a Foot and an half from the Bottom: They make the Foundation of these Hillocks broad, bringing them up tapering to the Top, where they leave a small hollow Pit to lay their Eggs in. And when they either lay their Eggs or hatch them, they stand all the while, not on the Hillock, but over it, with their Legs on the Ground in the Water, resting themselves against the Hillock, and covering the hollow Nest upon it with their Wings: For their Legs are very long, and building thus, as they do, upon the Ground, they could neither draw their Legs conveniently into their Nests, nor sit down upon them otherwise than by resting their whole Bodies there, to the Prejudice of their Eggs or Young, were it not for this admirable Contrivance, which they have by natural Instinct. They never lay more than three Eggs, and seldom fewer. The young ones cannot fly till they are almost full grown; but will run prodigiously fast. Thus far *Dampier*.

*Du Tertre*, in his History of the Isles, &c. gives these farther Circumstances. *Ces oyseaux, dit il, ont le ton de la voix si fort, qu'il n'y à personne, en les entendant, qui ne croust que ce sont des trompettes qui sonnent. Ils sont toujours en bandes, & pendant qu'ils ont la teste cachée, barbo-  
sant dans l' eau comme les Cygnes, pour trouver leur mange-  
aille, il y a toujours un en sentinelle tout de bout, le col éten-*  
du

dù, l'oeil circonfpect, & la teste inquiète. Si tost qu'il aperçoit quelqu'un, il sonne la trompette, donne l'alarme au quartier, prend le vol tout le premier, & tous les autres le suivent. Ils volent en ordre comme les Grues; que si l'on les peut surprendre, ils sont si facile à tuer, que les moindres blessures les font demeurer sur la place. Ils sont rares & ne se voyent jamais, si non dans les salines le plus éloignées du Peuple.

On les écorche, & de leur peaux on fait de fourreurs, que l'on dit estre tres utile a ceux qui sont travaillez des froideurs & debilité d'estomac

(p) Rochfort likewise informs us, That Ils ont l'Ouye & l'Odorat si subtile, qu'ils eventent de loin les chasseurs, & les armes à feu. Pour éviter aussi tout surprise, ils se posent volontiers en des lieux découverts, & au milieu de marécages, d'où ils peuvent appercevoir de loin leurs ennemis; & il y en a toujours un de la bande qui fait le guet. Ils sont gras & ont la chaire assez delicate. On conserve leur peau qui est convert d'un mol duvet, pour être employé aux mesmes usages que celles du Cygne & du Vautour.

De Laet observes, that these Birds are so accustomed to Salt Water, that the *Indians*, when they tame them, mix Salt with the fresh Water for them; else they pine away and die. And though *Aristophanes* says it is ὁ τῶν ἰνδιδῶν, or not used to be tame; yet *Gassendus* writes, that *M. Varius*, President of the Parliament at *Aix* in *Provence*, and a great Friend of *M. Peiresc*, used to divert himself with feeding them with Bread moistned with Water, which they commonly eat in the Night and not in the Day Time. The same learned Person observed, that they could discern the Approach of cold Weather, and would come to the Fire, so as sometimes to burn their Feet; and that when one Foot pained them, they would go upon the other, using their Bill instead

of the burnt Foot ; That they slept standing upright on one Foot, with the other drawn up to their Breast among their Feathers: And lastly, that very little Sleep served their Turn.

### Ufus.

This beautiful and scarce Bird was much esteemed by the *Romans*, and frequently made use of in their costly Sacrifices and sumptuous Entertainments. Thus *Suetonius* (q) describing the exquisite Sacrifices which were appointed by the mad Emperor *Caligula* to be offered to himself as a Divinity, says of them, *Hostiæ erant Phœnicopteri, Pavones, Tetraones, Numidicæ, Meliagrides, Phasianæ, quæ generatim per singulos dies immolarentur.* And the same Historian relates further (r), that this Emperor *pridè quam periret sacrificans respersus est Phœnicopteri sanguine.*

That the Tongue of this Volatile was much commended, and in great Esteem, for its excellent Taste and most delicious Relish, will appear from the following Quotations. And first we read in *Pliny* (s), that *Apicius* said the Tongue of this Bird was a delicious and savory Bit, *Phœnicopteri linguam præcipui esse saporis Apicius docuit, nepotum omnium altissimus gurgis.*

The Poet *Martial* says the same thing in the afore-cited Epigram:

*Dat mihi penna rubens nomen: sed lingua gulosis  
Nestra sapit;*

And *Juvenal* (t) in that Satyr where he exposes the extravagant Luxury and Gluttony of the *Romans*, men-

(q) *Suetonii Caligula*, §. 22. (r) *Scalig.* §. 57. (s) *Plinii Nat. Hist.* Lib. X. cap. 48. (t) *Juvenal. Sat.* XI.

tions this Fowl, amongst some others equally rare, that they made use of in their Feasts.

—*Et Scythica volucres & Phœnicopterus ingens.*

We read in *Suetonius* how the Emperor *Vitellius* had them often served at his Table, with a great many more Varieties brought from the most distant Parts of the Universe; his Words are, (u) *In hæc Scarorum jocinera, Phasianorum cerebella, linguas Phœnicopterum, Murenarum lactes à Carpathio usque fretoque Hispaniæ per Navarchos ac Triremes petitarum commiscuit*; hoc est, ab extremis imperii sinibus Orientem versus & Occidentem. And *Heliogabalus*, another of the Roman Emperors, as *Lampridius* writes, treated his Courtiers with sumptuous nice Dishes made of the Inwards and Brains of *Phœnicopters*, *exhibuit Palatinis ingentes dapes extis & cerebellis Phœnicopterorum refertas.*

What is related by *Gassendus* in the Life of that learned Nobleman *Petreskius*, is no Argument against the excellent Relish of the Tongue of this Bird: For his Friend *Varius*, who therein seems to contradict the received Opinion, was at that Time just upon the Recovery from a long illness; he had no Appetite, loathed all Sorts of Meats, and mended but very slowly; so that its no Wonder if he did not perceive all the Relish of that nice Bit, for which of old it was so much commended. Besides, his Answer is not as to the Tongue, which was owned to be much sweeter than that of a Kid, but to the Flesh of this Bird, (as will appear from the Original.) *Rogatus scinde fuit de sapore carnis Phœnicopteri. Excepit autem mirari se, cur illam Apicius apud Plinium, & Imperatores Caligula & Vitellius apud Suetonium, Heliogabalus apud Lampridium, & nonnulli alii tantis in deliciis habuissent. Esse enim eam injucundam, aut saporis certe non exquisiti, aquaticarum aliarum instar, cum etiam piscem oleat; unde à*

---

(u) *Suetonii Vitell. S. 13.*

*Provincialibus ut plurimum abjicitur, exuvieque solum sunt usui in fastuosis convivis, carnibus aliarum avium obtegendis.*

The Way to dress the *Phænicopter*, and how to make a Sauce fit for it, we may read in *Apicius's* Book *de Obsoniis & Condimentis*, seu *de Arte coquinariâ*, Lib. VI. c. 7.

*Phænicopterum elixas, lavas, ornas; includis in cacabum, adjicies aquam, salem & aceti modicum; dimidiâ cocturâ alligas fasciculum porri & coriandri ut coquatur: Prope cocturam defrutum mittis, coloras: adjicies in mortarium piper, cuminum, coriandrum, laseris radicem, mentham, rutam: fricabis: suffundis acetum: adjicies caryotam. Jus de suo sibi perfundis, reexinantes in eundem cacabum, amilo obligas, jus perfundis & inferes. Aliter. Assas avem, teres piper, ligusticum, apii semen, sesamum, defrutum, petroselinum, mentham, cepam siccam, caryotam; melle, vino, liquamine, accento, oleo & defruto temperabis.*

*Philostratus Puniceam Avem, i. e. Phænicopterum, inter mensarum delicias numerat, Lib. VIII. Vitæ Apoll.*

(x) *Wormius. Linguam hujus avis veteribus Romanis in deliciis olim fuisse docent cupediarum magistri Apicius & alii.*

*Dr. Grew. The Tongue of this Bird, as Apicius said, was a delicious Morfel amongst the Romans.*

*N. B. In the Treatise de Obsoniis & Condimentis, that goes under the Name of Apicius, there's no mention made of the Tongue of this Fowl: For as Dr. Lister well observes, Apicius noster hic filet de lingua præcipuo sapore: Which is a pretty convincing Proof, that this Book de re coquinaria, is only a Collection made by some modern Roman; the Name of the old Apicius, that great Master of the Art of Eating, being only prefixed to it, for the Benefit of the Bookseller.*

(x) *Miseum.*

*Dampier.* The Flesh of both young and old is lean and black, yet very good Meat, tasting neither fishy nor unsavory: A Dish of *Flamingo's* Tongues being fit for a Prince's Table. They are large, having a large Knob of Fat at the Root; which is an excellent Bit.

*Du Tertre.* La chair en est excellente, quoy qu'elle sent un peu la marine: mais sur tout la langue passe pour le plus friand morceau qui puisse etre mangé.

### Descriptio Partium.

#### Magnitudo.

According to *Bellenius* this Bird is of the Bigness of the Fowl he calls *Elorius*, which is our *Curlier*.

*Scaliger* compares it to the *Heron*, *magnitudo ei Ardea*.

*Gesner* says it is as big as a *Ciconia* or *Stork*, or rather bigger.

*Aldrovandus* writes, *de magnitudine ejus ego nihil certi assero, quia Avem nunquam vidi*.

*Dampier.* The *Flamingo* is a sort of large Fowl much like the *Heron* in Shape, but bigger and of a reddish Colour.

*Du Tertre.* Le *Flamand* est un oiseau gros comme une Oye sauvage.

#### Collum.

It hath an extraordinary long Neck according to Mr. *Willoughby*.

*Du Tertre.* Il a le cou rouge, fort menu pour la grandeur de l'oiseau, & long d'une demy Toise.

#### Cauda.

*Scaliger.* Caudam habet brevissimam ac veluti præcisam.

#### Rostrum & Caput.

*Scaliger* writes, that the Bill of this Fowl is neither straight nor altogether crooked: *Rostrum neque rectum*

N n n n

plane

planè, sed neque aduncum habet, Scythici arcus partem potiùs imitatur.

Gesner, who compares this Bird to the Crane for Bigness, adds, *Rostrum sesquialtera fere longitudine ad Ciconiæ rostrum, superius crasso & tuberculis quibusdam aspero.*

Aldrovandus commends the Account Scaliger gives of the Bill, and then adds, *in Rostris autem conformatione non parum lusit Natura; non enim ut Anatim aut Anserim planum est, cum alioqui sit latum, neque ut Ardearum rectum & rotundum, neque denique ut rapacium Aquilarum aut Accipitrum aduncum; cum tamen sit curvum quidem & deorsum inflexum, sed in medio superioris mandibula notabili exuberantia insigne, sex digitos longum, intus cavum & canaliculatum media sui parte. Superior etiam mandibula inferiori longior est, & in acutissimam aciem definit; contra vero inferior longè crassior.*

Du Tertre. *Il a la teste ronde & petite, à laquelle est attaché un gros bec, long de quatre pouces, moitié rouge & moitié noire, & recourbé en forme de cuëilliere.*

Olaus Wormius gives the following Description of the Head and Bill of the *Phanicoptes*, which he had sent him from a Friend, viz.

*Caput longitudine uncias octo superabat, ipsum caput, excepto rostro, trium erat. Rostrum ipsum figuram à Scaligero delineatam obtinet, in medio crassum satis sed curvum, superiore ejus parte utrinque ad latera caniculatum; ad sui exitum duobus grandibus foraminibus olfactui deputatis præditum, in extremitate aduncum, interne denticulatum cum costâ seu eminentiâ in medio. Pars vero inferior nigra, frequentibus prædita striis ad extremum excurrentibus; longitudine vero cedit superiori, sed ampla est & capax, crassæ lingue, quæ aberat, excipiendæ apta.*

Dr. Grew has obliged us with a very curious Account of the Bill of this Bird, for which he says it is most  
remark-

remarkable. The Figure of each Beak is truly Hyperbolical: The upper Jaw is ridged behind, before plain or flat, and pointed like a Sword, with the Extremity bended a little downwards: Within it hath an Angle or sharp Ridge, which runs all along the Middle, at the Top of the Hyperbole, not above a quarter of an Inch high: The lower Beak in the same Place above one Inch high, hollow, and the Margins strangely expanded inward, for the Breadth of above a quarter of an Inch, and somewhat convexly. They are both furnished with black Teeth, as I call them from their Use, of an unusual Figure, *scil.* slender, numerous, and parallel as in Ivory Combs; but also very short, scarce the eighth Part of an Inch deep. An admirable Invention of Nature, by the Help of which and of the sharp Ridge above-mentioned, this Bird holds his slippery Prey the faster.

Mr. Ray describes the *Rostrum* to be *latiusculum, singularis & infolia figura*; *mandibula nempe superior incurva, depressa, dentata*; *inferior crassior.*

*Menippus*, the Cynick Philosopher, in a Fragment of his *de Homine* (which however at this Time is either lost, or at least hard to be come at) affirms this Bird to move its upper Jaw, as we find him quoted by (y) *Rondeletius*, where he is talking of the Crocodile's moving that Mandible: His Words are, *sed id non soli ex omnibus animalibus Crocodilo peculiare, nam intra Aves, Phœnicopterus superiorem partem Rostris movet, ut annotavit Menippus Philosophus, Libro de Homine.*

*Gesner* makes the very same Quotation from *Rondeletius*.

(z) *Cardanus* repeats the same thing without Mention of any Author, *nam quidam existimant etiam Phœni-*

(y) *Rondel. Lib. de Amphibiis, Chap. 5.*

(z) *Carden. de Varietate Rerum, Lib. 7. Cap. 37.*



*copteros aves Mandibulam movere superiorem*; but subjoins, *sed non adeo manifesta causa est in Ave ut in Crocodilo.*

*Wormius* is of the same Opinion; but with *Cardan*, he thinks the Cause is not so manifest as in the Crocodile.

*Dr. Charleton* says, that it was *Cardanus* that first made that Observation.

*Dr. Grew* argues for this Movement from the peculiar Structure of the *Rostrum*; alledging, however, that there can be no Determination of these Matters, without Inspection into the Muscles, and the Articulation of the Bones. As for the *Phœnicopter*, says he, it must needs be said, that the Shape and Bigness of the upper Beak (which here, contrary to what it is in all other Birds that I have seen, is thinner and far less than the neither) speaks it to be the more fit for Motion, or to make the Appulse, and the neither to receive it.

#### *Crura & Pedes.*

*Bellonius* remarks, that the Legs of this Volatile are very long. And on the contrary,

\* *Scaliger* writes, *Crura pedesque sunt adeo breves, ut cum in Homine Galenus agnoverit longissimos, huic omnium, que nota sunt nobis, animalium brevissimos attribueret potuerit.* For this he is severely taxed by *Dr. Charlton*, *hic nobis candidè notandus occurrit error quidam Scaligeri egregius: Is nimirum in Exercit. in Arist. Hist. Animal. (this is wrong quoted, the Place being in Arist. Lib. de Generat. Anim.) peculiare Phœnicopteri notas satis prolixè describens, crura ei brevissima curtosque pedes attribuit, (verbis supra citatis) atque Avem hanc & cruribus & suris gradiri longissimis, omnium quotquot seu vivam seu mortuam contemplati sunt oculi confirmant. Et quis precor, ullam aliam, ex Aquaticarum fissipedum & piscivorarum classe, volucrem unquam conspexis brevibus pedibus in-*

---

\* *Scalig. Exercit. 233. § 2. de Subtilitate, ad Cardanum.*

*structam? Certè nemo. Neque consentaneum est, ut quas Naturæ consilium ad pisces in stagnis & fluviorum vadis, non natando sed grillatoriis veluti gradibus vadando, captandos destinaverit, eis crura concederentur tam necessario ad vitæ quærendum officio imparia. Ad hæc, non aliunde fuit quàm à proceritate crurum & colli, quod Phœnicopterus olim à Juvenale ingens diceretur.*

Dr. Grew observes the same Mistake, but in fewer Words, which are the following; *when Scaliger therefore said that this Bird hath the shortest Legs of any Animal yet known, he would have said the longest.*

Gesner says, it is *Cruribus rubris, ea proceritate qua in Ciconia sunt, vel procerioribus.*

Du Tertre. *C'est le plus haut monté de tous les oiseaux que J'ay jamais vu en ma vie. Il a les Jambes tout rouges, & les pieds à demi marin.*

(y) Rochfort. *Ils ont les jambes & les cuisses si hautes, que le reste de leur corps est élevé de terre de deux bons pieds ou environ.*

#### *Color Plumarum.*

Scaliger thus elegantly expresses the fine Colour of its Wings *Cinereum colorem nobilitant alarum punicea penne.*

Aldrovandus. *Mirum est cur nigrum alarum colorem non annotavit Scaliger. Cætera tota Avis ex cinereo, phœniceo & albo coloribus mistis spectatur.*

Gesner says, *Pennis albis parte prona; rubentibus per Collum, Pectus, Ventrem & Alas.* And speaking of one taken near Montpellier, he says, *tota alba, præter illas in alis partes quæ nigre sunt in Ciconiis*

(z) De Laet observes, that while they are young their Feathers are chiefly white; but as they grow up, they are painted with an Infinity of Colours. *Mais ils diffèrent en couleur, d'autant qu'ils ont le plumage blanc quand ils*

(y) Hist. des Antilles Edit. Rottord. p. 583.

(z) Hist. du Nouveau Monde, Lib. 1. Cap. 9. & Lib. 18. Cap. 15.

sont jeunes ; puis apres à mesure qu'ils croissent, ils devient de couleur de rose, & en fin quand ils sont agez, il est tout incarnat. Il se trouve de ce mêmes oiseaux, pres de Montpellier, qui ont seulement le dessous des ailes & du corps incarnat. & le dessus noir. Il s'en voit aussi aux Isles, qui ont les ailes mêlées de quelques plumes blanches & noires.

Du Tertre gives much the same account. Les Jeunes sont beaucoup plus blancs que les vieux, & ils rougissent à mesure qu'ils avancent en age. J'en ay veu aussi quelquesuns qui avoient les ailes mêlées de plumes rouges, noires & blanches, & je croy que ce sont les mâles.

(†) Constantinus, *Rostrum, & crura, & pars alarum, puniceo colore rutilat.*

Willoughby says, the Neck and Body is white : The *Alarum Remiges*, or Quill-Feathers of the Wings, are black ; but the *Vestitrices*, or Covert-Feathers, are wholly dyed with a most beautiful, bright purple, or flame Colour, *unde ei nomen.*

Dampier. The young ones at first are of a light grey ; and as their Wing-Feathers spring out, they grow darker, and never come to their right Colour, or any beautiful Shape, under ten or eleven Months old. When many of them are standing together by a Pond's Side, being half a Mile distant from a man, they appear to him like a Brick Wall ; their Feathers being of the Colour of a new red Brick : And they commonly stand upright and single, one by one exactly in a Row, except when feeding, and close by each other.

#### *Color Pedum.*

All Authors agree in the red Colour of its Legs and Feet. Thus Scaliger, *Crura pedesque alis habet concolores.*

(†) Constant. *Lexicon Græcæ-Latinæ.*

*Color Roſtri.*

*Gefner* ſays, *Colore rubro inſtar ſanguinis.*

*Aldrovandus* writes, *Pars qua ſpectat frontem ex albo ad Caſtanea colorem vergit, cetero nigrum.*

*Willoughby* affirms, that the Tip of the Bill is black, or of a dark blue.

*Figura.*

The whole Fowl is delineated by *Gefner* and *Aldrovandus*; and *Dr. Grew* has given us the Figure of the Head and Bill, as he found it amongſt the Rarities in *Greſham-College*. *N. B.* The Figure of the *Phænicopter* in *Willoughby*, is copyed from the ſecond of *Aldrovandus*. *Gefner* ſays the *Phænicopterus* whence his Figure was taken, was ſent to him by *Rondeletius*. *Aldrovandus* had the firſt of his Figures from *Sardinia*; and the ſecond, which he calls *Phænicopterus alter roſtro lato*, was given him by that famous Botaniſt *Carolus Cluſius*: He owns that he never ſaw the Bird himſelf.

In *de Rochfort*, the Body and Neck of the *Flammant* is pretty well delineated; but the Legs are not, neither is the Bill, nor the Claws.

(\*) *Du Hamel* gives a very exact Account of this Bird in the following Words, with which I'll cloſe this tedious and prolix Deſcription, collected from all the Authors that have made any mention of the *Phænicopter* or *Red-Wing*. *Collo prælongo, cruribus productis, exili pede ſed firmo donatur; oculi itidem anguſti ſunt & rubei; cyſtis fellea è parte inferiore hepatis eſt penſilis. Vas ipſum è quo ſuſpenderit, quove bilem excipit, amplum eſt, contra atque in Homine & in Quadrupedibus obſervatur; in his*

---

(\*) *Hiſt. Acad. Røale Edit. Paris, p. 213.*

*enim radices vesiculæ sunt admodum exiles. Oesophagus in sui initio valde angustus, paulatim latior factus in ingluviem seu in saccum ampliorem desinit : Ventriculus fere ut in Gallina, tametsi Granis non vescitur, sed parvis Conchyliis, quæ ventriculi musculis teruntur ut Grana. This Author tells us that the Phænicopte was dissected by Monsieur Perrault at Paris.*

*Ale ejus didactæ colorem illum rutilum exhibent, unde vulgo Flamand dici solet, non quod in Belgio reperiatur, sed quia ejus Plumæ per membranam pellucidam visæ colorem flammæ præbent : Vix ulla est Avis major : Rostrum ex utraque parte deorsum incurvatum, quod in ea Ave omnino est singulare; aratri enim instar inflectitur, unde & vulgo Becharü, quasi Aratrirostrum, appellatur. Hæc ille.*

When I get the Opportunity, which I do very much long for, of dissecting this fine Volatile with my own Hand, I shall then more particularly insist on the Anatomical Part; and, with all the Exactness I can, give a true Description of each *Viscus*. I proceed to the Explanation of the Figures, which were drawn from a *Flamingo* that was sent to Mr. Botley to be stuffed.

## The Explanation of the Figures. Tab. II.

*Fig. I.* Gives a Side-view of the Head and Bill.

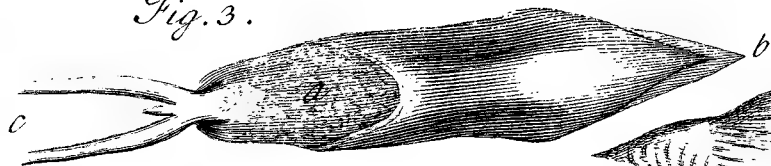
*Fig. II.* In this is represented a Front-view of the same Parts.

*Fig III.* Exhibits the under-side of the Tongue next the under Bill. In which *a* denotes a Cartilaginous Substance that covers the Tip or extremity of the Tongue; *b* a Glandulous Substance at its Basis; *c* the Horns of the *Os Hyoides*.

*Fig. IV.* In this the upper side of the Tongue is fairly delineated, upon which we see two Rows of strong *Papillæ Nervæ*; their *Apices* or Points turning inwards, for the better retention of the Prey.

*Fig. V.*

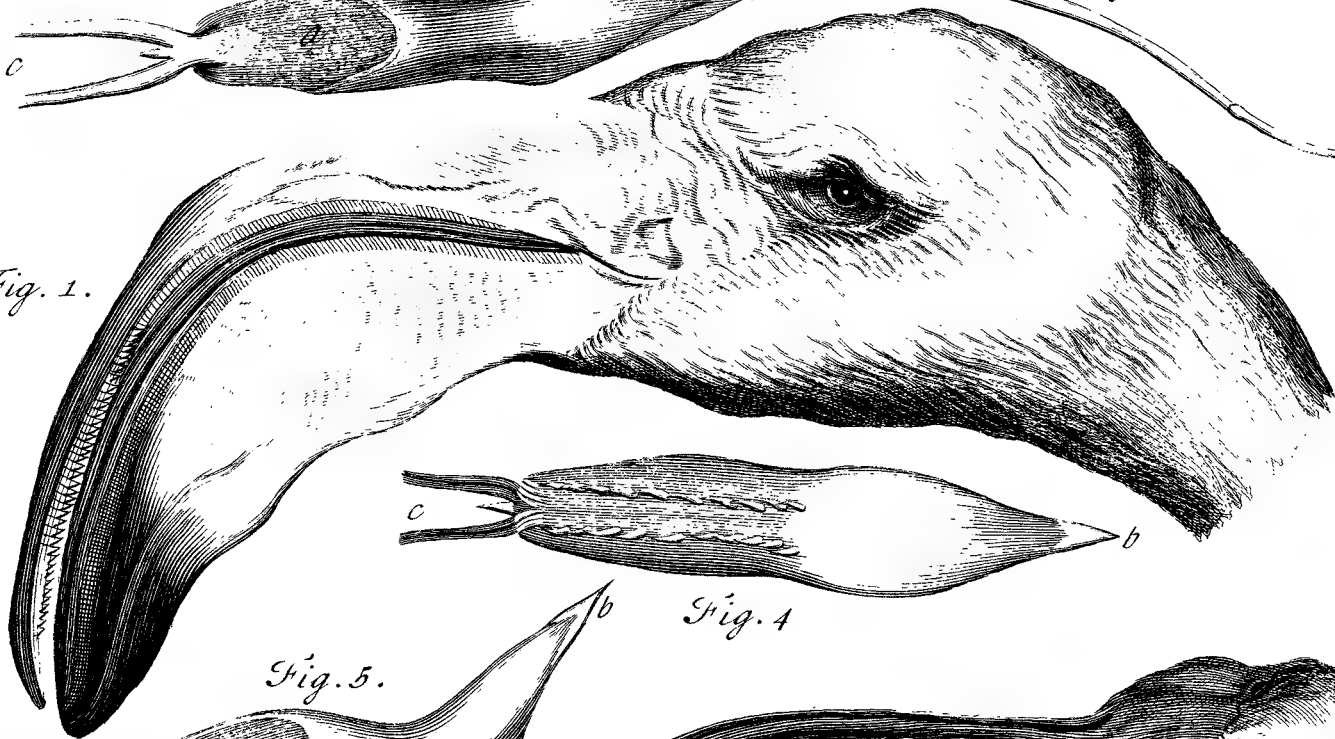
*Fig. 3.*



*Fig. 6.*



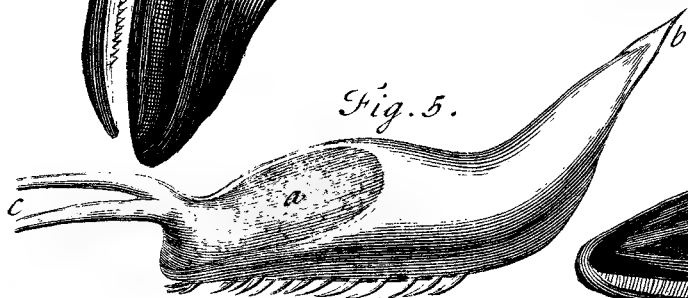
*Fig. 1.*



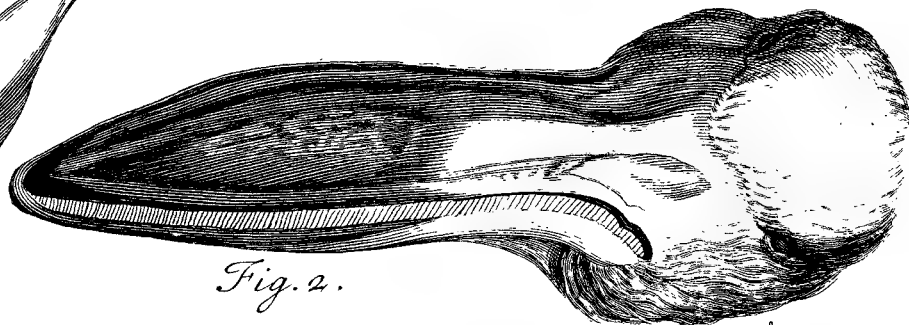
*Fig. 4.*



*Fig. 5.*



*Fig. 2.*



*Fig. V.* In this the Tongue is drawn in a lateral View, that we may have a Prospect of the true Figure of these *Papilla*, which being hooked and turn'd backwards prevent, in a great Measure, the return of any little Animal swallow'd alive, which they feed upon.

*Fig. VI.* The *Cornua* or Horns of the *Os Hyoidæum* are drawn in this last Figure, as all the other Parts are, as big as the Life.

## *Advertisement.*

**W**HEREAS some of our practising Surgeons, as I am inform'd, have taken Offence at a Passage in a Paper of mine, publish'd in the last *Philosophical Transactions*, viz. *By that sort of Enquiry the common Mistake of Surgeons was detected, and what was esteem'd and treated by them as a Luxation of the Head of the Os femoris, was discover'd to be nothing else but a fracture of the same Bone near it's Neck*; I take this first Opportunity to explain my self, that by the preceding Words I only meant the Writers of Surgery now extant, as may appear by my Quotations, and not in the least intended any Reflection on the present Practitioners in it. That skilful Society I not only Respect and Esteem for their great Merit and extensive Knowledge in the several Parts of their Profession, but to them am under many Obligations also, for the Honour they have done me in twice choosing me one of their Lecturers. I have this farther to add, that that Observation was publish'd entirely without my Knowledge about a Year after it had been read at a Meeting of the Royal Society.

*James Douglas.*

O o o o

An

An INDEX to this Nine and Twentieth Volume  
of the *Philosophical Transactions*. *n.* denotes the  
Number of the Tract, *p.* the Page.

**A**IR, how to be convey'd under the Water, *N.* 349.  
*p.* 497.

*Anatomy.* Dissection of the Bigbelly'd Woman of Haman  
in Shropshire, *n.* 348. *p.* 452. Ventriculus Cordis stupendæ  
magnitudinis, *n.* 345. *p.* 326. Microscopical Descrip-  
tion of the Fibres of the Muscles, *n.* 339. *p.* 55. 59. Mor-  
bid Glands in the Humane Spleen, *n.* 349. *p.* 500. A  
Fracture of the Head of the Os Femoris, *n.* 349. *p.* 501.  
*Anatomy* of the Wood-Pecker's Tongue, &c. *n.* 350. *p.* 509.

*Arithmetick.* Rules for Correcting the usual Computus  
by Compound and Simple Interest, *n.* 340. *p.* 111. Me-  
thods for making Logarithms, *n.* 338. *p.* 14. and *n.* 339.  
*p.* 52. Problematis Generalis ad Ludum Gallis La Poule  
dictum Solutio, *n.* 341. *p.* 133. Solutio altera, *n.* 341.  
*p.* 145.

*Astronomy.* Observatio Occultat Stellæ  $\tau$  Tauri Romæ  
Novemb. 21<sup>o</sup> 1713. & Eclipsis Lunæ statim infecuta,  
*n.* 340. *p.* 88. Eclipses primi Satel. Jovis ibid. *p.* 89.  
Eclipse of the Moon, Octob. 30. 1715. observ'd *n.* 347. *p.* 402.  
Eclipse of Jupiter by the Moon, Julii 14<sup>o</sup> 1715. *n.* 347.  
*p.* 401. Total Eclipse of the Sun, April 22<sup>o</sup> 1715. ob-  
serv'd, *n.* 343. *p.* 245. and *n.* 345. *p.* 314. Observa-  
tiones primæ Cometæ anni 1680. *n.* 342. *p.* 170. Nar-  
ratio de Stella Nova in Collo Cygni, *n.* 343. *p.* 226. — A  
short History of New Stars, *n.* 346. *p.* 354. Of Nebulæ  
or lucid Clouds among the fixt Stars, *n.* 347. *p.* 390. Ob-  
servationes Cœlestes Britannicæ, anno 1713. Grenovici  
habitæ, *n.* 344. *p.* 285. Observationes Planetarum Pri-  
mariorum annis 1715 and 1716. *n.* 350. *p.* 506. Me-  
thodus Singularis pro Solis Parallaxi, *n.* 348. *p.* 454.  
Cause of the Appearance of Venus by Day, *n.* 349. *p.* 466.  
*Aurora Borealis, vide Meteors.*

Barometrica



## B.

Barometrica Experimenta in Montibus Helvetiæ, n. 344. p. 266.

Accounts of Books : *Commercium Epistolicum Collinii*, &c. n. 342. p. 173. & seq. *Bibliographiæ Anatomiciæ Specimen* per J. Douglas, M. D. n. 343. p. 263. L. Ferd. *Marsilii* de Generatione Fungorum, n. 345. p. 350. Guil. *Musgrave*, Geta Britannicus, n. 346. p. 385. Guil. *Musgrave*, G. Fil. de Dea Salute. J. *Petiver* Botanicum Hortense IV. n. 343. p. 229. n. 344. p. 269. n. 346. p. 353. Linear Perspective by Dr. *Brook Taylor*, n. 344. p. 300. Methodus Incrementorum per D. B. *Taylor*, n. 345. p. 339. Ducatus *Leodiensis* Topog. by M. *Raiph Thoresby*, 344. p. 304.

## C.

Colours, see *Light*.

## D.

Diving, or the Art to live under Water, n. 349. p. 492.

## E.

Eclipses, see *Astronomy*. *Elephants Teeth* found in Ireland, n. 346. p. 387. Experiments. *Barometrica* in Helvetiæ montibus, n. 344. p. 266. Of *Light* and Colours repeated, n. 348. & 435. p. 448. Of the Law of the Encrease of the *Magnetical Attraction*, n. 344. p. 294. Of the Motion of the Sap in *Vegetables*, n. 349. p. 486.

## F.

*Flamingo* or *Phœnicopter*, it's Natural History, n. 350. p. 523. Account of *Falkstone Cliff* sinking, n. 349. p. 469. *Fruit-Stones* dangerous to swallow, n. 349. p. 484.

## G.

*Geometry*. Vera densitatis Aeris regula, n. 338. p. 41. Description and Quadrature of a kind of *Foliate Curve*, n. 345. p. 329. *Logometria* sive de Mensura Rationis, n. 338. p. 5. De divisibilitate *Materiae*, n. 339. p. 82. To find the Center of *Percussion* in Bodies, n. 345. p. 349. *Problematis*, de Motu Corporum, urgente Vi Centripeta quæ sit reciproce ut Cubi distantiarum a Centro, Solutio, n. 338. p. 35. Solutio altera ejusdem, p. 99. *Problematis* inversi *Virium Centripetarum* Solutio, n. 340. p. 91. *Problematis* olim in *Actis Lipsiæ* propositi Solutio generalis, n. 347. p. 399.

## I.

A Correction of the Computation of *Interest*, see *Arithmetic*. *Inoculation* of the *Small Pox*, n. 339. p. 72. and n. 347. p. 393.

## K.

A Recipe for the late pestilential Distemper among Kine,  
n. 338. p. 50.

## L.

Lakes why Salt, n. 344. p. 296. Of Light and Colours, see Experiments. Globes of Light seen in the Sky: see Meteors. Logarithms: see Arithmetic. Logometria: see Geometry.

## M.

Magellan-Streight, its Longitude, n. 341. p. 165. Mag-  
netical Attraction tried, n. 344. p. 294. Meteors. Ac-  
counts of several Luminous Globes seen in the Sky, n. 341.  
p. 159. Of the wonderful Aurora Borealis seen March 6<sup>th</sup>,  
1716. n. 347. p. 406. and n. 348. p. 430. Of the like  
March 31<sup>st</sup>, April 1<sup>st</sup> and 2<sup>d</sup>, following, n. 348. p. 431.  
Miscellaneous Observations on the Plants, &c. found about  
Rome and Naples, n. 349. p. 473. Moldiness, it's exceeding  
quick Vegetation, n. 349. p. 490.

## N.

Nautical Meridian Line divided Mechanically, n. 345. p. 331.

## P.

Root of Pareira Brava from Brasil, it's Use in Medicine,  
n. 346. p. 365. Phœnicopter see Flamingo. Plants growing  
about Rome and Naples, vid. Miscellanies. Microscopical  
Observations on the Motion of the Sap and of the growth  
Plants, n. 349. p. 487. Rare Plants growing about London,  
n. 343. p. 229. n. 344. p. 269. and 346. 353.

## R.

Rain its Quantity at Paris and Upminster, n. 341. p. 130.

## S.

Saliness of the Sea consider'd, n. 344. p. 296. Sinking of  
Falkstone-Cliff, n. 349. p. 469. Small-Pox, how inocu-  
lated, n. 347. p. 393. & seq.

## T.

Teeth of an Elephant found in Ireland, n. 346. p. 367.  
Reflections thereon, *ibid.* p. 370. Pike of Tinriffes curiously  
describ'd, n. 345. p. 317. Tongue of the Wood-Pecker, its  
Mechanism, n. 350. p. 509. Tongue of the Flamingo  
figured, n. 350. Tab. II. V.

Variation of the Compass consider'd, n. 341. p. 165.  
Vegetation of Moldiness how quick, n. 349. p. 490. Venus,  
when and why seen by day, n. 349. p. 466.

## W.

The Art of Living under Water, n. 349. p. 492. Wood-  
Pecker curiously describ'd, n. 350. p. 509.